SCIENCE LIBRARY 182

ENGINEERING AND MINING JOURNAL

METAL AND NON-METALLIC MINING · MILLING · SMELTING · REFINING · MARKETING

McGRAW-HILL PUBLISHING COMPANY, INC. December 7, 1929 TWENTY-FIVE CENTS PER COPY

More Cars Per Trip—More Coal Per Day

TIMKEN BEARING EQUIPPED

A much greater tonnage can be hauled from face to tipple in a day with Timken-equipped mine cars than with an equal number of plain bearing cars, because frictional power loss is reduced to the vanishing point.

And cars start so gently and run so smoothly on Timkens that coal breakage in hauling is practically eliminated.

With the decreased power demands come other equally important advantages, for car life is prolonged by Timken ability to carry *thrust* loads as well as radial loads; lubricant is saved and maintenance costs are cut to the bone by the exclusive combination of Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken steel.

In fact so comprehensive and so radical are Timken benefits that Timken Bearings enjoy almost exclusive dominance in the mine car field.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *Tapered Roller* **BEARINGS**

NATIONAL COPPER-STEEL PIPE...

GIVES ADDED PROTECTION TO EXPOSED METAL MINE PIPING

One of the important factors in the successful operation of a metal mine is the efficiency of the piping system. To be efficient, pipe lines must give more than satisfactory service for a limited time—they must give long life as well. Real efficiency means pipe that lasts on the job—pipe that does not cause frequent replacements with consequent loss of time, labor and materials.

One of the enemies of long life in pipe lines is corrosion—in many cases atmospheric corrosion. Due to the fact that a large portion of metal mine piping is constantly exposed to alternate wet and dry conditions, the matter of protection from atmospheric corrosion is one of prime importance. Fortunately, there is a simple but effective means of resisting atmospheric corrosion, namely—the use of copper-steel pipe.

Numerous tests and actual service records over a period of nearly twenty years have established the fact that a small amount of copper added to the steel makes it more resistant to corrosion caused by alternate wet and dry conditions, such as encountered in mining service. Steel being highly refined and homogeneous, the copper thoroughly alloys with the molten metal and the combination offers an added protection against atmospheric corrosion.

As the pioneer in the research and development of copper-steel pipe, National Tube Company is in a position to recommend to metal mine operators the use of NATIONAL Copper-Steel Pipe for all exposed piping, such as, air, water, pump lines, and wherever pipe is exposed to atmospheric corrosion. Ask for Bulletin No. 11 describing

NATIONAL COPPER-STEEL PIPE
The Original Copper-Steel Pipe

NATIONAL TUBE COMPANY · Pittsburgh, Pa.
Subsidiary of United States Steel Corporation

NATIONAL COPPER-STEEL PIPE

ENGINEERING AND MINING JOURNAL, December 7, 1929. Vol. 128, No. 23. Published weekly. McGraw-Hill Publishing Company, Inc., Tenth Avenue at 36th Street, New York, N. Y. United States, $6 a year; 25 cents a copy. U. S. Possessions, Mexico and the countries of Central and South America, $7.50 a year. All other foreign countries, $10 a year. Entered as second-class matter, June 20, 1879, at the Post Office, New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A.

ENGINEERING AND MINING JOURNAL

A consolidation of "Engineering and Mining Journal" and "Mining and Scientific Press"

Associate Editors
E. H. ROBIE, A. H. HUBBELL
New York
GEORGE J. YOUNG, San Francisco

A. W. ALLEN, *Editor*

Assistant Editors
W. N. P. REED, H. D. KEISER
S. D. STRAUSS
Market Editor: H. H. WANDER
Publishing Director: H. W. CLARKE

Contents for December 7, 1929

VOLUME 128, NUMBER 23

Copyright, 1929, by McGraw-Hill Publishing Company, Inc.

Editorials 875

GAINING a Perspective of Plant Operations . . . Capital Deserves a Living Dividend . . . Death Valley Boom Predicted from Denver . . . North America's Copper Refining Facilities Increase . . . Are Lost-Time Accident Records Always What They Seem? . . . Broken Hill Operators Merge Interests for Common Gain . . . Taking the Charity and Uncertainty Out of Old-Age Pension Plans

Recovering Gold in Alaska and Yukon Territory 878

ILLUSTRATIONS.

The Importance of Classification in Fine Grinding 880

J. V. N. DORR and A. D. MARRIOTT

The Outlook for the Northern Rhodesian Copper Fields 888

OWEN LETCHER

Additional Curtailment of Production Necessary in Tri-State District .. 897

J. H. WADLEIGH

Comment and Criticism .. 892
Industrial Progress 893
Personal Notes 896
Obituaries 896
Mining News 897
Market and Financial News 905
Metal Statistics 907
Market Report 908
Mining Stocks 912
Service Directory 47
Searchlight Section 48
What and Where to Buy 52
Advertising Index 56

McGRAW-HILL PUBLISHING COMPANY, INC., Tenth Ave. at 36th St., New York, N. Y.

CABLE ADDRESS: "MACHINIST, N. Y."

JAMES H. MCGRAW, *Chairman of the Board*
MALCOLM MUIR, *President*
JAMES H. MCGRAW, JR., *Vice-Pres. and Treas.*
EDWARD J. MEHREN, *Vice-President*
MASON BRITTON, *Vice-President*
EDGAR KOBAK, *Vice-President*
HAROLD W. MCGRAW, *Vice-President*
H. C. PARMELEE, *Editorial Director*
C. H. THOMPSON, *Secretary*

Member A.B.P.
Member A.B.C.

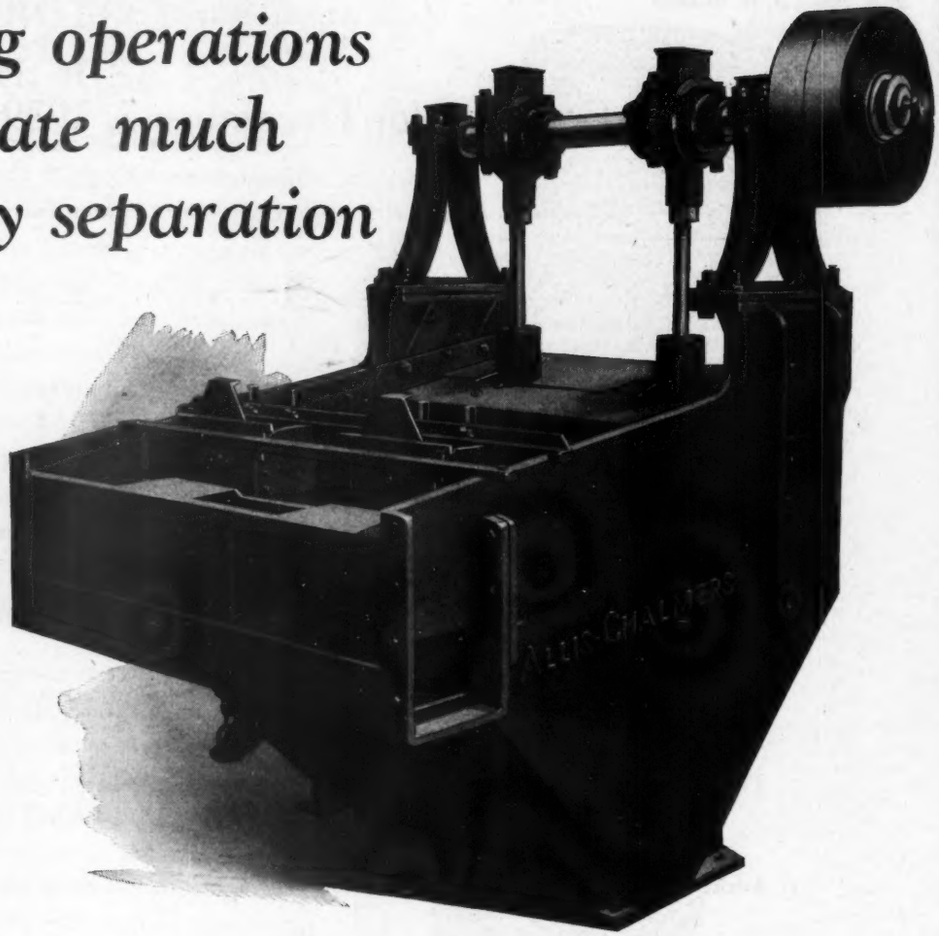
NEW YORK, *District Office, 285 Madison Avenue*
BOSTON, *1427 Statler Building*
WASHINGTON, *National Press Building*
CHICAGO, *520 N. Michigan Avenue*
PHILADELPHIA, *1600 Arch Street*
CLEVELAND, *Guardian Building*
DETROIT, *j-257 General Motors Bldg.*
ST. LOUIS, *Bell Telephone Building*
GREENVILLE, S. C., *1303 Woodside Bldg.*
SAN FRANCISCO, *883 Mission Street*
LONDON, *6 Bouverie Street, London, E. C. 4*

11,000 COPIES PRINTED THIS ISSUE

TOTAL NUMBER OF ISSUES TO DATE 3,31

Woodbury Jigs

Combine classifying and jigging operations and eliminate much preliminary separation



48" Woodbury Slime Classifier and Jig

THE economy of the Woodbury System of Concentration consists primarily in the simplification of the processes intervening between the crushing section of a mill and the smelter. Summarized, its advantages are as follows:

Capacity.—Units of large capacity, thus retiring a large area of jig sieves.

Mixed Feeds.—By uniting the classifying and jigging operations into one, fewer sizing screens and elevators are used, and hydraulic classifiers eliminated.

Slime Separation.—A dense original slime, treated direct on tables, retires a large settling tank area.

Concentrates.—Recoveries and grade of concentrates are increased.

Middlings.—An improved middling classification, reducing quantity to be recrushed.

Tailings.—Lower tailing losses obtained in all cases.

Water.—Milling water less by one-half.

Power.—Costs reduced materially.

Labor.—Costs per ton of ore reduced.

Floor Area.—Always less, and in some cases cut in two.

Construction.—All iron and mechanically correct.

ALLIS-CHALMERS

MILWAUKEE, WIS. U.S.A.

ENGINEERING AND
MINING JOURNAL

A McGraw-Hill Publication | A. W. ALLEN, *Editor* | Established 1866

Volume 128 | New York, December 7, 1929 | Number 23

Gaining a Perspective of Plant Operations

THE increasing demand for reduction in operating cost, increase in recovery, the full utilization of byproducts, and the maintenance of a standard quality of the finished product has tended to complicate the metallurgical flow sheet. Formerly the operation of a plant resolved itself into a few specific divisions, but that of the modern installation has been complicated by the addition of small auxiliary units, some of which may operate intermittently or at constantly varying capacity.

Frequent change and improvement in the design and construction of machinery and equipment have also added to the number of variables introduced, necessitating closer and more systematic supervision. With the magnitude of modern operation, a change in procedure or equipment does not always manifest itself in improved or impaired result as readily as was the case in a smaller plant with a less complex structure. In fact, radical changes in the operation of secondary units may not cause disturbance until after weeks or even months have elapsed. The superintendent, when asked to explain a variation in operating result, is at a disadvantage if his records are not kept in a manner permitting a good perspective of all operations.

To study the data in those operating records directly connected with a particular problem at hand may only add to the confusion. Detached figures, unless interpreted in connection with other correlated facts, may mislead. He will be best able to disentangle the interlaced data who can visualize past and present operations in their entirety, noting the changes in equipment and flow sheet that have been made, and the operating methods adopted—all in their proper sequence. The result of such a procedure may cause regret at a realization of the lack of foresight and proper planning. The analysis will be helpful in prompting the planning of a more efficient system of technical accountancy and survey.

One operator has developed a system whereby the men directly in charge of the various units of his department submit a short daily report of all important events in their specific units, giving adequate emphasis to extraordinary incidents that would not appear on the stereotyped operating report. From these individual reports a daily summary is compiled, covering the entire operations, which summary is exhibited in each section of the plant, allowing each foreman a chance to familiarize himself with the other branches of the department.

At the end of each month the daily summaries are grouped into a single report. The idea may be carried still further, half-yearly or yearly reports being compiled to represent the history of the department during six months or a year. Properly arranged and indexed, such reports will make available a comprehensive picture of operations whenever needed. If kept within easy reach at his desk, the official in charge will find constant use for them as emergencies arise. Such reports are not intended to take the place of regular operating records, which, of course, should provide complete data on each specific phase of the work.

Capital Deserves A Living Dividend

THE achievement of a new and more harmonious relationship between employer and employee is exemplified by recent history in the United States. According to statistics furnished by the Department of Labor, so-called industrial disputes declined from 3,789 in 1916 to 571 in 1928. This progress is due in some measure to a general raise in the scale of wages, but it may be traced more directly to a better understanding by the worker of basic economic principles and a fuller realization of the part he must play in any sound and progressive industrial program—a program that aims to secure the broadest possible prosperity and contentment.

Speaking at a meeting of the Chamber of Commerce of the Borough of Queens, Long Island, recently, Mr. Howell Cheney affirmed that the only true measure of compensation for capital or labor is that of service rendered. Any concept of remuneration based on the so-called living wage or saving wage indicates a faulty analysis of the economic relationship between labor and capital, and their joint relation to production. The opinion was also expressed that wage theories are inadequate which are based on the presumption that increased remuneration to labor necessarily results in increased consumption, and that the ultimate result is the stimulation of production.

A living wage may mean one thing to one man and something entirely different to another. Wages rose enormously during the War, as also did living costs. Although average individual wage earnings are now much more than they were in 1914, the cost of living has again fallen, providing one reason for the passage into oblivion of the phrase "living wage." Instead, the term "luxury wage" has been evolved—to denote remuneration that permits the worker to enjoy something more than is needed to meet the necessities of life.

Mr. Cheney pointed out that no industry can live if remuneration to the worker is out of proportion to the amount he produces. The contention has been raised

that wages should be increased in proportion to the increase in production, but attention is rarely paid to the fact that this increased output is largely if not wholly due to improved equipment and processing technique, which have required an additional capital investment that has added to the fixed charges on the earnings of the industry. Wages could-not have been maintained at the levels reached during the last ten years but for this investment in expert help, power, and efficient machinery. As a result, most of the workers of today enjoy not only a living wage but a luxury wage, possible largely because of increased production and of scientific development, resulting in lower price levels. Many luxuries of yesteryear are considered the necessities of today, a reduction in cost to the consumer having brought many such commodities within the range of almost every pocketbook. As Mr. Cheney rightly points out, if a yardstick is needed to adjust compensation, let it be the measure of service rendered, for capital as well as for labor.

Death Valley Boom Predicted From Denver

FLORID reports from Denver announce a find of gold in Death Valley, but interested parties are not urged to pay a visit to the property. "It is 114 deg. in the shade today," warns the manager in a letter apparently sent to a Denver brokerage house, giving the details of the discovery. "It is the richest gold ore that I have ever panned in this desert," which is non-committal. "Coarse and yellow. Seems that we are going right into a big chimney."

A few days later the pannings "gave over $300 a ton in fine gold, rock that did not show gold under the glass . . . . red and yellow oxide. The last few days we have been pulling boulders out of the hanging wall, weighing twenty to thirty pounds. Solid oxides and pans free gold over a hundred a ton. The little slabs of hematite full of free gold is not the width of the vein in No. 2 shaft. We have over thirty-three of these between footwall and hanging wall, about six feet, the talc in between iron veinlets assaying $37.60 gold, which is free, no concentrates."

"This is not fiction, although it sounds almost too good to be true," one is told. The manager at the "mine," who is described as an "old-time, hard-shelled mining engineer, a man who is not easily excited, a man to whom ordinary good ore means little or nothing out of the ordinary, states . . . . that the present strike is of boom proportions. He has taken the precaution to send the news to the office by mail, refraining from using the telegraph, because news of this kind is of sufficient importance to cause a stampede," and "he does not want a boom town to spring up overnight at his water supply; he does not want a horde of miners and prospectors milling over the property, which he feels certain the news of this strike would cause to rush to Death Valley."

No! What the Death Valley Exploration Company wants is a stampede of prospective suckers. On the basis of uncorroborated reports of a few pannings in that desolate region, the public is approached to subscribe up to $600,000 for the purchase of penny shares. If you buy one thousand all at once, you can get a discount of fifty cents. If you have no cash you are invited to trade-in other stocks. "Subject to final confirmation," you are allowed four cents per share on Burnham Chemical; five cents on Idaho Copper; one and one-half cents on Swift Sure Mining, and so on.

The irresponsible and questionable promotion is a parasitic growth on the mining industry, causing lack of confidence in legitimate enterprise as well as a loss of money that should be diverted into profitable channels. The statements in the Death Valley Exploration prospectus indicate that the public is expected to be as gullible as the promoter is evidently brazen.

North America's Copper Refining Facilities Increase

THOUGH Rhodesia has had much more publicity recently as a prospective center of copper production than any other district, one must not assume that North America, which last year produced 60 per cent of the world's copper, is becoming of decreasing importance. One evidence of the fact that the copper productive capacity of this continent is still growing may be seen in the recent and prospective construction of refineries. This month the new Nichols refinery at El Paso will be placed in commission, the first new plant of that kind to be constructed since 1916, when the new Anaconda plant at Great Falls, Mont., and the Consolidated refinery at Trail, B. C., were completed. Nichols Copper, of course, has another refinery at Laurel Hill, N. Y.; and a good part of the blister destined for the El Paso plant has heretofore gone to the Perth Amboy refinery of American Smelting & Refining; but no reason exists for assuming that either of these older plants will lack a sufficient supply of blister, even with the new Nichols El Paso plant in operation. In Canada, the Ontario Refining Company, subsidiary of International Nickel, American Metal, and Consolidated Mining & Smelting, is erecting a new copper and nickel refinery at Copper Cliff; and a new company—Canadian Copper Refiners—in which the Nichols company is interested, plans soon to start the construction of a brand new refinery at tidewater in eastern Canada, presumably to handle the Noranda and Hudson Bay Mining & Smelting production along with that of smaller companies.

Assuming a productive capacity of the new El Paso plant at 100,000 tons per annum, that of the Copper Cliff refinery at 120,000 tons, and that of the other proposed Canadian plant at 80,000 tons, there is thus added a total of 300,000 tons of refining capacity to the continent's facilities, which is surely proof that the North American copper industry is not languishing. The increasing importance of the Nichols organization in the copper-refining business is also to be noted. A few years ago, when the Phelps Dodge copper was transferred from the Laurel Hill plant to Perth Amboy, some thought that Nichols was passing out of the picture. But the present production of that plant, about 180,000 tons, plus the 180,000 tons expected from the two other plants, will make Nichols not greatly inferior to American Smelting & Refining or Anaconda Copper as a factor in copper refining.

Are Lost-Time Accident Records Always What They Seem?

PRAISEWORTHY as are the efforts of managers to maintain their records unblemished by lost-time accidents, the suspicion occasionally arises that these records are sometimes forced. In the ordinary course of events it would seem difficult in some plants to avoid minor accidents, which, although not serious enough to compel the injured person to lay off, are nevertheless of such a nature that he would do wisely to go home until all chance of a secondary and more serious development has disappeared.

At least one important mining company takes such a view. Its policy underground is illustrative of its attitude. In its mines the water is said to be as bad for skin cuts as it is corrosive to equipment. Here the ore fragments are often sharp and jagged, so that the miners frequently suffer lesions of the skin. Left to himself, the workman, with his eye naturally upon the pay check, would continue at his post. Not if the operator knows it, however. When such mishaps occur, the men are at once sent out in order to prevent mine water from getting in the cut, although this policy makes the company's accident record seemingly worse than the records of operators elsewhere.

In a recent bulletin, the United States Bureau of Mines declares that "the press for mine production must not be allowed to outweigh or precede safety considerations." This it holds to be one of the factors vital to lessening accidents in the mining industry. Here the word "mine" must be interpreted broadly. The advice is just as good for mill operators as for those in charge of mines. And bear in mind that little difference may exist between pressing for mine or mill production and pressing for an unblemished lost-time accident record.

Broken Hill Operators Merge Interests for Common Gain

ALTHOUGH deliberations extending over a period of more than six years preceded the recent ordering of equipment for the Broken Hill Mines' Joint Power Station to be erected at Broken Hill, Australia, the mining companies of the district that have made the project possible—namely, Broken Hill South, Zinc Corporation, and North Broken Hill—are to be congratulated on reaching the mutual understanding that has led to this co-operative effort.

The steam plants now employed at the mines "along the Barrier" are expensive producers of power, owing chiefly to their comparatively small capacity and the relatively high price of coal delivered at Broken Hill. The new station will be equipped with six Sulzer Diesel oil engines coupled directly to British Thomson Houston generators and four Mirrlees, Bickerton & Day Diesel oil engines driving Belliss & Morcom air compressors. Both electric current and compressed air will be distributed from the station to the mining properties at rates representing important economies, in comparison with the present power costs of the individual companies principally concerned.

In this joint power station, the cost of which will be equivalent to two and a half million dollars, the Broken Hill mining companies have demonstrated their ability to merge their individual interests for common gain, and have materially strengthened their economic position.

Taking the Charity and Uncertainty Out of Old-Age Pension Plans

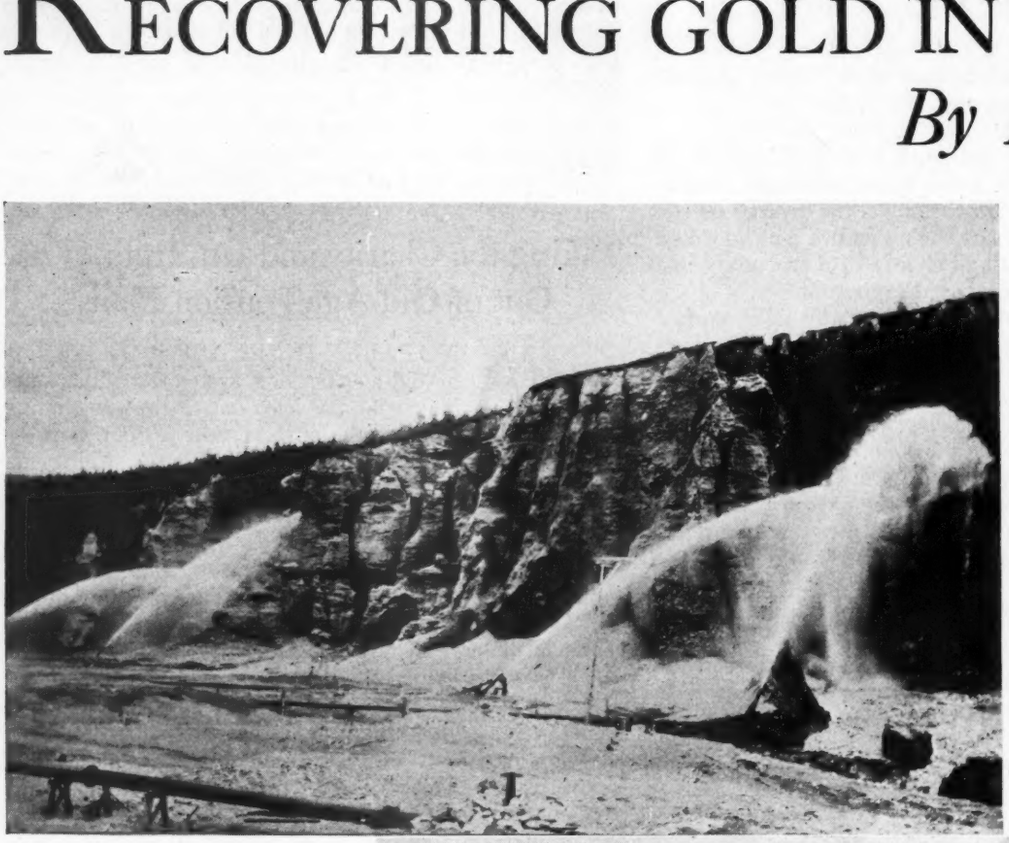
A NOTABLE INCREASE in the adoption of old-age pension systems, political and industrial, has been one of the outstanding social developments of the current year. Four states—Minnesota, Utah, Wyoming, and, recently, California—provided for the establishment of such systems and brought the total number of states passing old-age pension legislation up to ten, the six others being Colorado, Kentucky, Maryland, Montana, Nevada, and Wisconsin. Three of the nine provinces of Canada—British Columbia, Manitoba, and Saskatchewan—are already paying pensions under a federal law, and similar action is expected soon by Alberta and Ontario.

In the industrial world the subject has likewise received increased attention, numerous companies establishing employee pension systems, some of which include special benefit plans covering accident, health, and death payments to dependents. Many of these systems have been found, on adoption, to be subject to serious objections from both the employer and employee. One, however, which has been evolved for the Westinghouse Electric & Manufacturing Company by Dr. Henry E. Jackson, of the Social Engineering Institute, after five years' study, apparently promises to obviate all such objections and to raise the establishment of a pension plan to as sound and economical a basis as any other phase of industry.

The plan is based on the theory that depreciation of human machinery is a proper charge against production costs, and that it pays to treat this cost as a regular operating expense. It not only provides for the employee an earned reward proportional to length of service, but, through its co-operative feature, affords him an opportunity to purchase additional retirement income at a favorable rate. In operation, the plan does not function as a dole or charity, nor does it offer any obstacle to continued employment of the older workers. The company's obligations are covered by a deed of trust, and those of the employee are underwritten by one of the larger insurance companies. Without further discussing numerous other features, one may add that from the standpoint of cost the plan demonstrates that, in percentage of payroll, its maximum annual cost for all years to come can be determined accurately. This cost is low, and the actual net cost is still lower. The net cost to the Westinghouse company is estimated at 1.2 per cent of the payroll.

As industry grows to recognize more generally its responsibility for the care of aged workers, and as the high cost of inefficient methods of handling the problem becomes apparent, many companies will undoubtedly find in the Westinghouse plan much that is worthy of study and many features that can be put into practice.

RECOVERING GOLD IN ALASKA
By Hydraulic,



Hydraulicking a placer deposit in Lovett Gulch, Yukon Territory

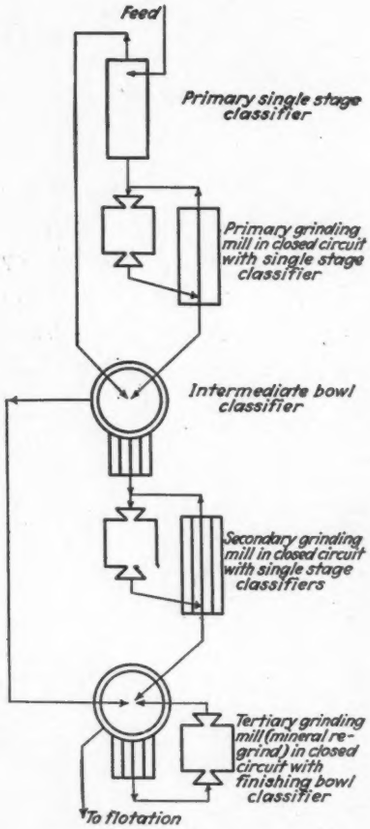
Washing operations near the Fairbanks district, Alaska

AND YUKON TERRITORY
Dredging, and Re-treatment Operations

Re-treating a dump at the Discovery mine, along Cleary Creek, in the Fairbanks district, Alaska

Dredging operations in the Bonanza basin, Yukon Territory

The IMPORTANCE *of* CLASSIFICATION *in*


Feed
Primary single stage classifier
Primary grinding mill in closed circuit with single stage classifier
Intermediate bowl classifier
Secondary grinding mill in closed circuit with single stage classifiers
Tertiary grinding mill (mineral re-grind) in closed circuit with finishing bowl classifier
To flotation

Grinding flow sheet suggested by the authors

WHEN closed-circuit grinding was first introduced into metallurgy some years ago, its value was recognized at once, and since then the combination of mills and classifiers has been regarded as a grinding unit and operated as such. Apart from variations both in the grinding and classifying elements of this unit, many variations in grouping have been tried by different mills to suit varying conditions of ore and plant limitations. Although operators feel that in most cases their present flow sheets are still on trial, we have felt that a discussion of the progress made and an endeavor to show present trends and their results should be of use. We therefore present flow sheets of some of the larger mills with which we have been in contact, with available data as to their results. The data given, though incomplete, indicate great progress in reducing grinding costs, increasing recoveries, and improving conditions.

The discussion is confined to wet fine grinding with mechanical classifiers, particularly as carried on in nine large copper plants of the western part of North America, and has necessarily been limited to information obtained from contact with the machines with which the authors are familiar, namely, the Dorr classifier and bowl classifier.

Each of these plants has remodeled its fine-grinding flow sheet several times in the last few years, with striking differences in results. Changes are shown by flow-sheet diagrams, and results obtained in each instance have been indicated, so far as available data would permit, in the tabulations and remarks accompanying. Some of these flow sheets apply only to test sections.

The basic figures upon which comparisons of flow sheets are made have been chosen as the best available for definitely indicating present trends. They have been derived as follows:

"Rated Section Tonnage" is either the average tonnage handled during a test or the average over an extended normal operating period on which reliable data were available.

"Unit Power Consumption"—kilowatt-hour per ton ground, unless otherwise noted—is the daily section tonnage divided into the daily kilowatt-hour consumption of the fine-grinding section. It usually includes power consumed not only by cylindrical mills but also by classifiers, pumps, conveyors, elevators, and other accessories.

"Comparative Screen Analyses" were taken from actual mill operating records or from reports of tests, and represent conditions prevailing when the section was handling its "Rated Section Tonnage."

"Metallurgical Results" were obtained in the same manner as the screen analyses. It should be noted that "%Cu" refers to total copper present, regardless of the nature of its occurrence (sulphide, oxide, carbonate). Consequently, the relative recoveries of available copper (copper sulphide) are masked in these figures.

"Tons Ground per Day Through 100

Table I—Cananea Consolidated

Comparative Capacities and Unit Power Consumption

Six Months' Average Operation

	Flow Sheet 1	Flow Sheet 2
Rated section tonnage per day	707	1018
Unit power consumption—kilowatt-hour per ton ground		
Primary mills	3.05	2.20
Secondary mills	4.93	4.32
Classifiers and elevators	0.34	0.18
	8.32	6.70
	Flow Sheet 1	**Flow Sheet 2**
Unit steel consumption—Pounds per ton		
Primary circuit	0.713	0.459
Secondary circuit	1.328	1.283
Total	2.041	1.742
Tons ground per day through 100 mesh	510	798
Unit power consumption—kilowatt-hour per ton —100 mesh	11.52	8.53
Tons ground per day through 200 mesh	412	700
Unit power consumption—kilowatt-hour per ton —200 mesh	14.30	9.73

Comparative Screen Analysis

	Flow Sheet 1 — Mesh				Flow Sheet 2 — Mesh			
	+48	+65	+100	−200	+48	+65	+100	−200
Section feed	82.5	86.0	89.8	5.8	87.0	89.4	92.7	4.4
Primary mill discharge	41.6	51.6	58.2	33.8	59.4	66.0	70.8	23.4
Primary classifier overflow	....	....	....	....	42.0	49.2	55.6	36.2
Bowl classifier overflow(a)	....	....	....	....	1.6	4.8	10.4	78.4
Secondary classifier overflow	2.0	8.6	17.4	69.0	1.1	7.2	16.5	68.6
Combined flotation heading	2.0	8.6	17.4	69.0	1.3	6.2	14.2	73.1

(a) Bowl overflow = 40 per cent section tonnage.

Comparative Metallurgical Results

Six Months' Average Operation

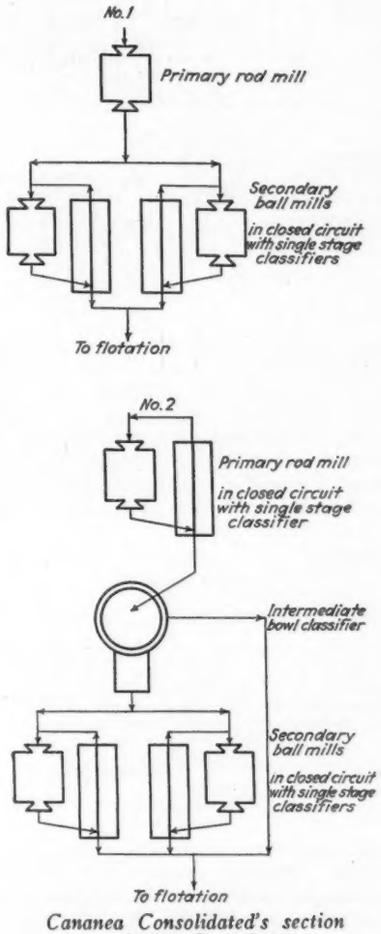
	Flow Sheet 1	Flow Sheet 2
Heads, per cent Cu	3.52	3.39
Concentrate	22.60	21.77
Tailing	0.181	0.173
Concentration ratio	6.70	6.72
Recovery	95.69	95.69

Presented at the Milling Session of the San Francisco meeting of the A.I.M.E., October, 1929.

J. V. N. Dorr and A. D. Marriott

in FINE GRINDING

As Demonstrated By the Development of Flow Sheets at Nine Concentrators in North America



Cananea Consolidated's section grinding flow sheets

Mesh" was derived by multiplying the "Rated Section Tonnage" by the difference between the percentage of plus-100 mesh in feed and the percentage of plus-100 mesh in the flotation heading, both percentages being expressed as decimal fractions.

Cananea Consolidated's mill consists of three sections, two of which are represented by flow sheet 1 and the third of which is represented by flow sheet 2. Increase in section capacity, reduction in unit power consumption for fine grinding and consumption of grinding media, and the slightly finer over-all grind are of particular interest in this case, since these improvements were made by increasing the classification capacity and increasing the ball load of the secondary mills from 8 to 15 tons of balls.

Advantages of closing the primary circuit have been brought out convincingly by numerous tests, the averages showing that it has increased the tonnage ground through 48 mesh 29.2 per cent, equivalent to 105.8 additional tons of minus-48-mesh product per day, or an estimated saving of $30.68.

The intermediate bowl classifier removes 40 per cent of the section tonnage which has been finished to flotation heading size in the primary circuit. The unfinished remainder is delivered to the secondary circuit in a deslimed condition and is reground to finished size without difficulty, since the ball mills now produce 7.37 tons minus-48-mesh material per mill hour in flow sheet 2, compared with 5.6 tons in flow sheet 1. This increase is the result of an increase that has been made in ball load and of better classification.

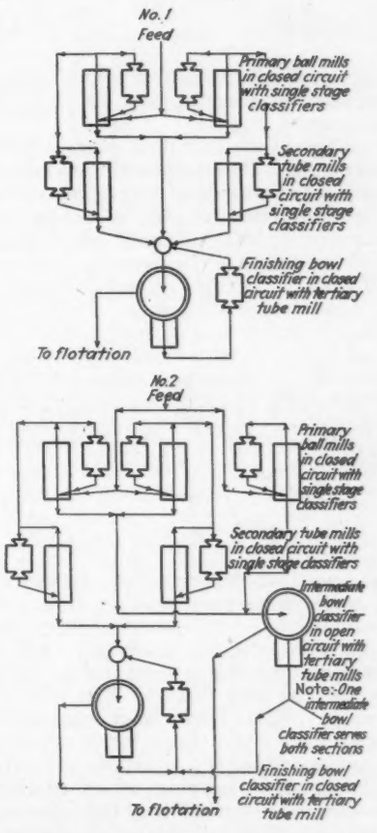
Granby Consolidated's Allenby mill consists of two sections. Flow sheet 1 represents a fine-grinding section after the addition of finishing bowl classifiers in 1925. Flow sheet 2 represents a fine-grinding section as of 1929, with the exception that the intermediate bowl classifier serves both sections, reclassifying equal portions of primary classifier overflow from each.

The flotation heading produced in flow sheet 1, handling about 100 tons per day, was found to contain too great a percentage of plus-65 and 100-mesh material.

Flow sheet 2 was subsequently adopted for both mill sections, and the plus-100-mesh material in the flotation heading was reduced by 10 to 15 per cent, the section tonnage being increased from 1,000 tons per day to 1,250 tons. The two flow sheets are compared on the basis of tons ground per mill-hour.

A much larger percentage of the feed was ground through both 100 mesh (78.6 per cent, as compared with 66.9 per cent) and 200 mesh (65.5 per cent, as compared with 49.5 per cent) by means of the additional equipment and its arrangement in flow sheet 2. This is of great importance, since tailing losses were found to mount rapidly in the plus-200-mesh material, and to be relatively even higher in the plus-100-mesh material.

Soon after the adoption of flow sheet 2 the operators found it necessary to raise the grade of concentrate owing to freight charges and smelter rates. Since all the copper in the plus-200-mesh sizes

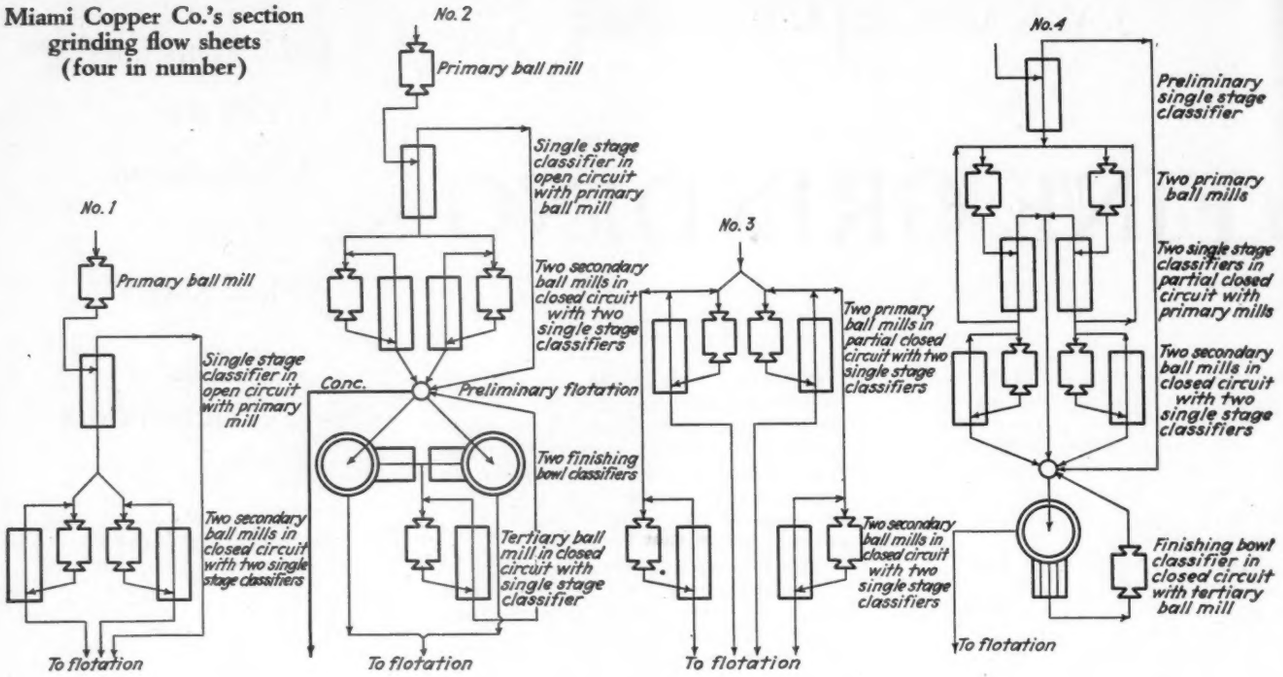

No. 1 Feed
Primary ball mills in closed circuit with single stage classifiers
Secondary tube mills in closed circuit with single stage classifiers
Finishing bowl classifier in closed circuit with tertiary tube mill
To flotation
No. 2 Feed
Primary ball mills in closed circuit with single stage classifiers
Secondary tube mills in closed circuit with single stage classifiers
Intermediate bowl classifier in open circuit with tertiary tube mills
Note:-One intermediate bowl classifier serves both sections
Finishing bowl classifier in closed circuit with tertiary tube mill
To flotation

Granby Consolidated's section grinding flow sheets. Allenby concentrator

is attached to gangue, regrinding of the coarse material in the rougher concentrates was decided upon. The effect of this change is brought clearly out in Table II.

Miami Copper has gone through four stages of experimentation in developing fine-grinding flow sheets. Flow sheets 1, 2, and 3 were used at various times from 1923 to 1929; flow sheet 4 represents the final development as of August, 1929, which, excepting the pre-

Miami Copper Co.'s section grinding flow sheets (four in number)


No. 2
Primary ball mill
Single stage classifier in open circuit with primary ball mill
Two secondary ball mills in closed circuit with two single stage classifiers
Conc.
Preliminary flotation
Two finishing bowl classifiers
Tertiary ball mill in closed circuit with single stage classifier
To flotation
No. 1
Primary ball mill
Single stage classifier in open circuit with primary mill
Two secondary ball mills in closed circuit with two single stage classifiers
To flotation
No. 3
Two primary ball mills in partial closed circuit with two single stage classifiers
Two secondary ball mills in closed circuit with two single stage classifiers
To flotation
No. 4
Preliminary single stage classifier
Two primary ball mills
Two single stage classifiers in partial closed circuit with primary mills
Two secondary ball mills in closed circuit with two single stage classifiers
Finishing bowl classifier in closed circuit with tertiary ball mill
To flotation

liminary classifiers used only in two sections, is now in use in all of the six sections.

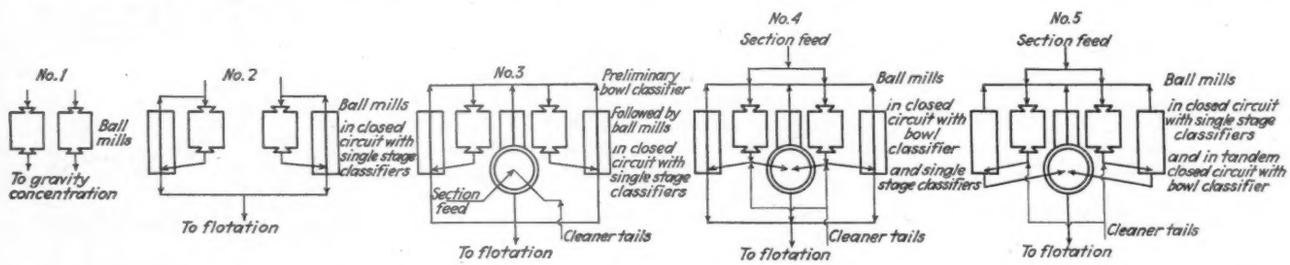
Whereas the first flow sheet provided only for closed-circuited secondary mills, the succeeding ones demonstrated the desirability of partly closing the primary circuit, finishing all flotation heading in bowl classifiers closed-circuited with tertiary regrind mills, and desliming the roll product before introduction into the primaries. All of these features have been incorporated in the final flow sheet 4. The primary circuit would have been completely closed had it not been for insufficient secondary classifier overflow capacity.

Progressive stepping up of tonnage handled per section has been accomplished without corresponding increase in unit power consumption.

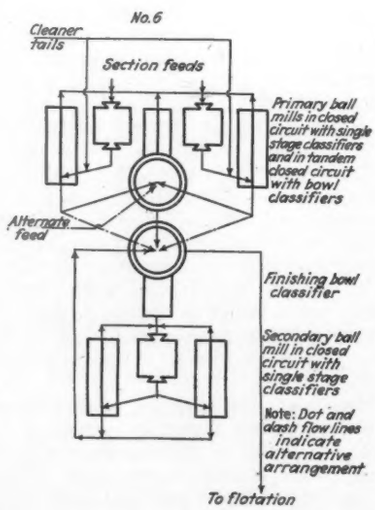
A study of comparative screen analyses shows that the tendency recently has been to grind coarser prior to the first step in flotation, and for this reason the unit power consumption per ton minus 100 mesh and minus 200 mesh does not show the decreases which might be expected. Present practice at Miami calls for rough concentration of the coarse-grinding section product followed by regrinding in a separate circuit prior to final concentration.

Where assays are available there is ample evidence of the concentration of mineral in the classifier discharges and the consequent selective grinding action which subjects the mineral to a finer degree of comminution than the gangue. The density of flotation heading has increased, especially after the introduction of the large finishing bowl classifier in flow sheet 4, overflowing to subsequent flotation as indicated at 38 per cent solids.

Miami practice today is an example of three-stage fine grinding with all flotation heading originating at a single point, convenient for adjustment of density and fineness. Ample classifier capacity ahead of and between the various stages, with the exception of the under-capacity secondary classifiers, permits finished material to escape quickly as soon as it has received the treatment intended by that particular stage.



Above, five of the flow sheets developed successively by Nevada Consolidated, at McGill, Nev. Below, the latest (No. 6) of the series


No.6
Cleaner tails
Section feeds
Primary ball mills in closed circuit with single stage classifiers and in tandem closed circuit with bowl classifiers
Alternate feed
Finishing bowl classifier
Secondary ball mill in closed circuit with single stage classifiers
Note: Dot and dash flow lines indicate alternative arrangement
To flotation

Nevada Consolidated's mill at McGill, Nev., has over a period of years tested five types of fine-grinding layouts and at the present time is making preparations to operate a test section with the arrangement indicated in flow sheet 6. Flow sheet 1, simple, single-stage, open-circuit grinding, was used prior to 1919 for preparing ore for gravity concentration; 2 was applied in 1919, when flotation was adopted; 3 was tried early in 1928, and 4 and 5 were subjected to competitive tests that have been conducted in 1929.

From the start there has been a progressive increase in section tonnage without use of additional mills, a reduction in unit power consumption, a reduction in tailing assay, and an increase in recovery. The grinding and classifying equipment used in flow sheets 3, 4, and 5 is identical, and all three flow

Table II—Granby Consolidated, Allenby Plant

Screen Analysis and Copper Assay
Flotation Concentrate, Flow Sheet 2

Mesh	Before Adoption Concentrate Regrind — Cum. Per Cent Wt.	Before Adoption Concentrate Regrind — Per Cent Cu.	After Adoption Concentrate Regrind — Cum. Per Cent Wt.	After Adoption Concentrate Regrind — Per Cent Cu
+ 65	1.76	12.28	....	....
+100	10.54	11.39	0.50	17.37
+150	16.80	12.73	1.60	20.45
+200	27.80	14.79	4.44	19.93
+270	38.72	17.84	9.44	19.63
+325	46.86	23.76	18.44	21.33
—325	100.00	36.85	100.00	35.43
Average		27.10		32.54

Comparative Capacities and Unit Power Consumptions

	Flow Sheet 1	Flow Sheet 2
Rated section tonnage per day	1,056	1,257.4
Tons ground per mill-hour	8.8	8.7
Tons ground per day through 100 mesh	706.0	987.9
Tons ground per mill-hour through 100 mesh	5.88	6.85
Tons ground per day through 200 mesh	522.0	824.0
Tons ground per mill-hour through 200 mesh	4.35	5.72

Comparative Screen Analyses

	Flow Sheet 1 — Tons	Per Cent Sol	+48	+65	+100	—200	Flow Sheet 2 — Tons	Per Cent Sol	+48	+65	+100	—200
Section feed	1,056	....	81.60	83.78	86.14	11.62	1,257.4	....	81.60	83.78	86.14	11.62
Primary classifier overflow	672	....	(a)	25.24	35.27	48.40	961.1	35.8	5.57	12.77	34.74	51.43
Intermediate bowl overflow	....	....	....	....	....	....	797.8	30.0	....	....	6.17	80.86
Secondary classifier overflow	384	....	....	25.24	35.27	48.40 b	....	....	....	....	....	....
Finishing bowl feed	....	41.8	....	17.77	39.94	44.53	....	....	9.33	28.83	59.56	21.44
Finishing bowl overflow	1,056	28.0	....	4.60	19.20	61.10	459.6	16.1	....	....	10.00	70.56
Flotation heading	1,056	28.0	....	4.60	19.20	61.10	1,257.4	22.8	....	....	7.57	77.15
Flotation tailing	....	....	....	2.70	13.64	62.12	....	....	....	....	....	....

(a) Screen figures given as combined primary and secondary classifier overflows. (b) Tonnage one-half that actually handled by intermediate bowl which serves both sections.

Comparative Metallurgical Results

	Flow Sheet 1	Flow Sheet 2
Heads, per cent Cu	1.448	1.508
Concentrates, per cent Cu	27.10	32.54
Tails, per cent Cu	0.277	0.223
Concentration ratio	22.906	25.149
Recovery	81.705	85.80

Table III—Miami

Comparative Capacities and Unit Power Consumptions

	Flow Sheet 1	2	3	4
Rated section tonnage per day	1,278	1,483	1,480	2,821
Unit power consumption—kilowatt-hour per ton milled	6.23	7.24	7.16	5.84
Tons ground per day through 100 mesh	804	1,043	969	1,552
Power consumption kilowatt-hour per ton —100 mesh	9.90	10.29	10.94	10.61
Tons ground per day through 200 mesh	616	762	721	1,131
Power consumption kilowatt-hour per ton —200 mesh	12.92	14.09	14.69	14.56

Comparative Metallurgical Results

	Flow Sheet 1	2	3	4
Heads, per cent Cu	1.74	1.711	1.686	0.81
Concentrates per cent Cu	42.26	47.176	39.993	38.02
Tailing per cent Cu	0.28	0.24	0.27	0.18
Concentration ratio	28.75	31.91	28.05	60.06
Recovery	84.40	86.30	84.50	78.10

Comparative Screen Analyses

	Flow Sheet 1 — Tons	Per Cent % Cu	% Sol	+48	+65	+100	—200	Flow Sheet 2 — Tons	Per Cent % Cu	% Sol	+48	+65	+100	—200
Section feed	1,278	1.81	100	76.4	78.7	81.5	14.6	1,483	1.64	100	77.9	79.8	82.4	13.8
Preliminary classifier overflow	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Primary mill discharge	1,278	1.81	65	49.6	55.3	61.3	29.0	1,483	1.64	74.7	58.3	62.7	67.7	25.4
Primary classifier overflow	472	1.60	28.1	0.8	5.0	13.6	69.3	494	1.60	39.0	8.5	15.5	25.8	59.
Secondary mill discharge	2,414	2.99	70.	33.8	49.3	62.	24.	3,169	....	73.5	48.2	59.4	68.6	21.2
Secondary classifier overflow	806	1.85	35.1	1.8	8.8	22.2	55.2	989	1.73	36.0	5.8	14.6	28.6	51.8
Finishing bowl classifier feed	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Finishing bowl classifier overflow	....	....	....	....	....	....	....	1,483	....	22.8	0	2.2	12.1	65.2
Regrind mill discharge	....	....	....	....	....	....	....	2,022	0.77	63.4	14.0	40.8	66.5	83.2
Regrind classifier overflow	....	....	....	....	....	....	....	1,142	0.56	47.3	8.8	30.1	58.8	77.4
Flotation heading	1,278	1.81	33.6	1.6	7.3	18.6	62.8	1,483	....	22.8	0	2.2	12.1	65.2
	Flow Sheet 3							Flow Sheet 4						
Section feed	1,480	1.69	100	80.9	82.9	85.2	11.6	2,821	....	97	75.6	78.4	81.8	13.7
Preliminary classifier overflow	....	....	....	....	....	....	....	471.1	....	39.7	17.5	23.8	33.1	52.6
Primary mill discharge	2,335	1.75	71.2	52.3	60.2	67.3	23.5	3,171	....	65.6	62.2	67.1	73.3	19.9
Primary classifier overflow	623	1.55	26.7	0.3	1.8	9	72	1,529	....	53.9	40.5	48.5	57.2	31.7
Secondary mill discharge	2,150	2.63	69	32.1	48.9	62.2	24.8	1,693	....	63.7	39.9	50.1	60.2	27.9
Secondary classifier overflow	856	2.04	31.8	5.6	16.7	34.3	43.8	821	....	38.8	14.1	26.0	39.2	43.2
Finishing bowl classifier feed	....	....	....	....	....	....	....	7,404	....	57.1	35.1	48.7	60.2	27.5
Finishing bowl classifier overflow	....	....	....	....	....	....	....	2,821	....	38.0	3.9	13.2	26.8	53.8
Regrind mill discharge	....	....	....	....	....	....	....	....	....	68.9	40.5	55.3	69.9	18.6
Regrind classifier overflow	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Flotation heading	1,480	1.69	29.6	2.3	7.5	19.7	60.3	2,821	....	38.0	3.9	13.2	26.8	53.8

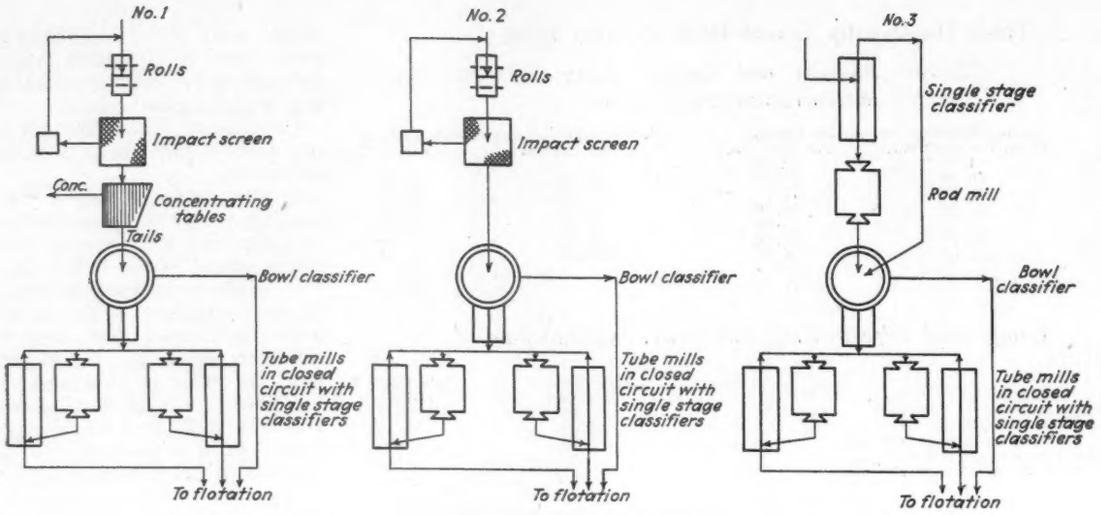
sheets were tested simultaneously, yet flow sheet 5, producing the coarsest over-all grind, appeared to give the best metallurgical results.

Conclusions drawn from the comparative tests of flow sheets 3, 4, and 5 are as follows:

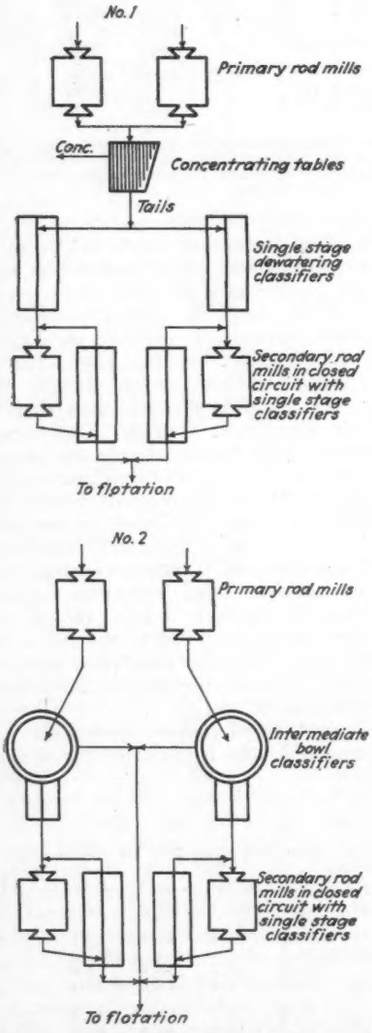
1. Flow sheet 3, where the section heading is sent to the preliminary bowl classifier for the removal of primary slimes ahead of the ball mills, appears to provide for greater section tonnage or finer grinding, with the same tonnage, than either flow sheet 4, where the bowl is in parallel closed circuit with the mills, or flow sheet 5, where the bowl is in tandem closed circuit with the mills and single-stage classifiers. This is probably owing to the removal of finished material at the outset, thus providing more opportunity for useful reduction of unfinished material in the mills.

2. Flow sheet 5, with the bowl in tandem, appears to produce conditions in the flotation heading conducive to increased recovery, even though the over-all grind is coarser than that of either flow sheet 3 or 4. The reason is presumably that relatively coarse and non-floatable particles of cleaner tailing and even insufficiently ground new sulphides are easily included in the pulp overflowing the single-stage classifiers, but are not readily overflowed from the more efficient bowl classifiers, which, acting as sulphide traps, return the coarse, heavy particles to the ball mills until more complete liberation and selective grinding of mineral have been accomplished.

3. A study of copper losses with flow sheets 3, 4, and 5 indicates the superi-



Flow sheets developed at Nevada Consolidated's Hayden concentrator (Arizona)



Phelps Dodge Corporation's section grinding flow sheets, Copper Queen Branch, Bisbee, Ariz.

ority of flow sheet 5, in the handling of both the plus-100-mesh and minus-100-mesh tailing. As compared with No. 4, flow sheet 3 showed a saving in the plus-100-mesh tailing, due probably to the more efficient operation of the ball mills with a deslimed feed. On the other hand, flow sheet 4 showed a saving in the minus-100-mesh tailing, probably a result of ball-mill treatment of the entire section heading and the consequent cleaning or polishing of the surfaces of the sulphides in the primary slime.

As a result of these tests a new and improved flow sheet 6 will be experimented with soon. This combines the desirable features of flow sheet 5 with a secondary regrind circuit and an intermediate finishing bowl classifier between stages of grinding. Ample provision is made for concentration of sulphides in bowl classifiers and their selective regrinding in a separate circuit. As indicated by the dotted lines, preliminary desliming may be employed to secure the copper savings in the plus-100 mesh indicated by the test on flow sheet 3.

A study of the test results tabulated herewith indicated that even with the coarser grind on flow sheet 5 this arrangement produced the best metallurgy, and a longer test period on the entire plant was established using this flow sheet.

In operating the first fifteen days of September, 1929, on the same tonnage per mill as in the tests described, increased grinding has been shown, as is evidenced by the figure for this period of 30.6 per cent plus-100 mesh as compared to 36.4 per cent plus 100 mesh.

At Hayden three different fine-grinding flow sheets have been experimented with by Nevada Consolidated in recent years. Flow sheet 2 is in use in seven of the eight sections, and flow sheet 3 is being studied in the test section, though data are not yet available. The decided reduction in milling costs as shown in recent annual reports of the company has been accomplished by improved methods of operating with existing facilities.

The tests which first warranted the fine-grinding flow sheet have been confirmed subsequently and show decided advantage in large circulating loads between mills and classifiers, due both to improved over-all grinding efficiency and to selective grinding of the minerals. This would appear to be borne out by the fact that practice today with flow sheet 2, compared with earlier practice with flow sheet 1, shows a 16.7 per cent capacity increase, accompanied by a coarser over-all grind (11.2 per cent plus 100 mesh against 7.4 per cent plus 100 mesh), a reduc-

United Verde Copper Co.'s section grinding flow sheets, Clarkdale, Ariz.

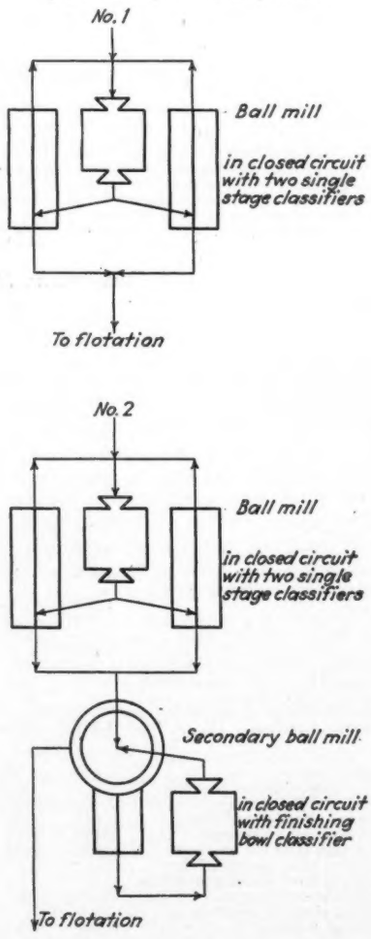


Table IV—Nevada Consolidated, McGill, Nev.

Comparative Capacities and Unit Power Consumption

	Flow Sheet 1	2	3	4(b)	5
Rated section tonnage	1,730	2,090	2,910	2,940	2,880
Tons ground per mill-hour	18	21.8	30.3	30.6	30
Unit power consumption—kilowatt-hour per ton milled (a)	6.3	5.2	3.7	3.7	3.8
Tons ground per day through 100 mesh	806	863	1,362	1,329	927
Power consumption—kilowatt-hour per ton—100 mesh	13.5	12.6	7.9	8.2	11.7
Tons ground per day through 200 mesh	....	623	1,004	1,000	706
Power consumption—kilowatt-hour per ton—200 mesh	....	17.4	10.8	10.9	15.4

(a) Mills only.
(b) Flow sheet 4 to date has proved unfavorable because of difficult operating conditions.

Partial Comparative Screen Analyses

	Flow Sheet 1	2	3	4	5
Average section feed					
+48	22.52	60.4	61.8	61.8	58.9
+65	.....	67.2	67.8	67.8	64.0
+100	95.2	71.8	72.8	72.8	68.6
—200	.....	22.3	20.6	20.6	24.0
Average section tailing					
+48	23.6	7.8	2.9	4.2	9.0
+65	.....	19.9	14.0	16.7	21.8
+100	48.6	30.5	26.0	27.6	36.4
—200	.....	52.1	55.1	54.6	48.5

Complete Screen Analyses Flow Sheet 5

	+48	+65	+100	—100
Section feed	58.9	64.0	68.6	31.4
Ball mill discharge	42.8	57.0	67.8	32.2
Single stage classifier overflow	17.1	30.3	43.3	56.7
Bowl classifier overflow	6.2	14.9	26.6	73.4
Flotation heading	6.2	14.9	26.6	73.4

Comparative Metallurgical Results

(Average of daily averages during sixteen-day test)

	Flow Sheet 3	4	5
Heads, per cent Cu	1.157	1.167	1.163
Concentrate, per cent Cu	21.67	20.78	19.78
Tailings, per cent Cu	0.142	0.145	0.113
Recovery	87.94	87.93	90.27
Concentration ratio	21.75	20.67	19.33

Daily Loss of Copper in Section Tailing

	Flow Sheet 3	4	5
Section tonnage per day	2,880	2,880	2,880
Per cent copper in +100 mesh tailing	0.178	0.207	0.152
Per cent copper in —100 mesh tailing	0.139	0.130	0.114
Pounds of copper per day in +100 mesh tailing	3,168	3,925	3,080
Pounds of copper per day in —100 mesh tailing	5,165	4,462	3,917
Total pounds copper lost per day	8,333	8,587	6,997

Table V—Nevada Consolidated, Ray Mines

Comparative Capacities and Unit Power Consumptions

	Flow Sheet 1	2
Rated section tonnage per day	1,500	1,750
Unit power consumption—kilowatt-hour per ton milled		
Primary circuit (rolls and screens or rod mill and classifier) (a)	4.01	3.38
Tube mill circuit (b)	3.79	3.58
Total	7.80	6.96
Tons ground per day through 100 mesh	1,200	1,324
Unit power consumption—kilowatt-hour per ton —100 mesh	9.75	9.20
Tons ground per day through 200 mesh	988	1042
Unit power consumption—kilowatt-hour per ton —200 mesh	11.84	11.69

(a) 91.9 per cent = roll power.
8.1 per cent = screens and elevators.
(b) 90.4 per cent = tube mill power.
9.6 per cent = classifiers and elevators.
Note—The wet roll-screen operation to about 10 mesh, though properly a crushing operation, is, for the purpose of future comparison, referred to here as a primary grinding circuit.

Comparative Screen Analyses

	Flow Sheet 1							Flow Sheet 2						
	Tons	Per Cent Sol	Per Cent Cu	+48	+65	+100	—200	Tons	Per Cent Sol	Per Cent Cu	+48	+65	+100	—200
Section feed	1,500	100	1.33	84.4	86.	87.4	11.6	1,750	96.5	1.29	83.96	85.2	86.86	10.85
Preliminary classifier overflow	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Primary circuit product	1,500	57	1.011	31.6	37.4	43.4	48.5	1,750	50.8	1.29	40.6	46.3	52.	40.3
Bowl classifier overflow (a)	725	20	1.037	0	0	0.9	91.	700	27.4	0.84	....	....	5.9	82.2
Tube mill discharge	3,000	....	1.75	27.	43.6	59.5	24.8	....	76.1	2.88	25.8	39.9	58.8	22.2
Secondary classifier overflow	875	30	0.985	0	2.2	11.7	68.6	1,050	33.5	1.60	....	2.1	14.8	62.6
Flotation heading (calculated)	1,450	25	....	....	1.2	7.4	77.5	1,750	....	....	....	1.4	11.2	70.4

(a) 150 tons returned to secondary classifier.

tion in kilowatt-hour per ton from 7.80 to 6.96, a slight reduction in tailing assay, and an increase in concentration ratio and a decrease in recovery.

Concentration of mineral in the classifier sands is striking and results in highly desirable selective grinding. Whereas in past years the bowl classifier was operated to produce an all through 100-mesh product, today the bowl is operated so as to unload at approximately the same mesh as the secondary classifiers, this resulting in a reduction of the feed to the mills and a greater density of overflow to flotation.

Although the flotation heading is considerably coarser than formerly, the mineral constituent is receiving the same or even a finer grind.

Hayden operation today represents a striking instance of selective grinding of minerals, the providing of ample classifier capacity and the judicious balancing of fine-grinding costs against metallurgical results. Hayden was the first mill to adopt the open circuit bowl classifier desliming ahead of ball mills, a practice which has been widely followed elsewhere.

The two flow sheets and comparative operating data on the Copper Queen concentrator represent practice before gravity concentration was finally discontinued in 1924; also practice in 1926, which is still in force. Adoption of flow sheet 2 in 1926 was accompanied by a substantial reduction in tonnage per section, as the management intended to sacrifice capacity in the interests of much finer grinding and the consequent increase in concentration ratio and reduction in sulphide losses. In Copper Queen ore, copper sulphide and pyrite are closely interassociated, and that the mineral constituent of the flotation heading should be ground largely through 200 mesh to secure partial selectivity was easily demonstrated.

Bowl classifiers were accordingly installed between the two stages of grinding to facilitate finer separations and selective grinding of the mineral, and to act as deslimers, producing a clean sand product with a minimum of finished material for further grinding in the secondary mills. These bowls remove 50 per cent of finished flotation heading at a greater density than was possible in single-stage classifiers, and thus reduce greatly the tonnage to be handled in the secondary circuit.

Expected improvements in metallurgy have been secured and, according to the officials, are due chiefly to the elimination of gravity processes in favor of all-flotation treatment, finer grinding to separate more effectively not only the mineral from the gangue, but also the copper constituent from the pyrite. The rearrangement of roughers and recleaners have likewise helped.

United Verde, having recently found from flotation research that a finer grind might prove advantageous in treating schist ores and that a very fine

Table VI—Copper Queen

Comparative Capacities and Unit Power Consumption

	Flow Sheet 1	Flow Sheet 2
Rated section tonnage per day	1,137	967
Unit power consumption—kilowatt-hour per ton	7.47	10.13
Unit steel consumption—pounds per ton		
Grinding media	2.29	3.02
Mill liners	0.81	0.70
Total	3.10	3.72
Tons ground per day through 100 mesh	809	832
Unit power consumption kilowatt-hour per ton 100 mesh	10.49	11.93
Tons ground per day through 200 mesh	550	648
Unit power consumption—kilowatt-hour per ton 200 mesh	15.46	15.31

Comparative Screen Analyses

	Flow Sheet 1				Flow Sheet 2			
	+48	+65	+100	−200	+48	+65	+100	−200
Section feed	91.0	92.24	93.78	4.4	90.97	92.27	93.44	4.96
Primary mill discharge	34.1	43.94	56.04	29.29	16.24	27.14	38.37	44.29
Bowl classifier overflow (a)	.....	.....	.....	.....	.....	.....	5.20	75.00
Secondary classifier overflow	3.50	.....	22.64	52.76	.....	.....	9.62	68.96
Combined flotation heading	3.50	.....	22.64	52.76	.....	.....	7.41	71.98

(a) Bowl classifier overflow = 50 per cent section tonnage.

Comparative Metallurgical Results

	Flow Sheet 1	Flow Sheet 2
Heads, per cent Cu	1.59	2.10
Concentrate, per cent Cu	6.48	15.20
Tailing per cent Cu	0.19	0.21
Concentration ratio	4.49	7.93
Recovery	90.71	91.26

grind was essential to unlock the various minerals in certain massive sulphide ores, installed additional equipment in one of its two fine-grinding sections to determine the extent to which the extra cost of finer grinding would be repaid in better metallurgy. Flow sheet 1 represents the original fine-grinding layout as now in use in Section 2 and flow sheet 2 is the new flow sheet in Section 1, with provision for finer grinding.

From these tests the following conclusions were reached:

1. Two-stage fine grinding is more efficient than single stage from the standpoint of power consumption, notwithstanding the lack of sufficient classifier capacity in the two-stage flow sheet and an incorrect slope of primary classifiers.

2. Large circulating loads between classifiers and ball mills, 3 to 1 in primary and 5 to 1 in secondary circuit, are essential to maximum output of finished material and correct application of ball sizes.

3. A tonnage of 900 tons per day in the two-stage grinding flow sheet gives the best balance between milling costs and metallurgical improvements. At this tonnage, total milling costs per ton should be slightly less than the corresponding figure for the single-stage flow sheet handling 600 tons per day, and a substantial operating profit should be derived, in increased tonnage, lower tailing assay, and improved grade of concentrate.

4. At 900 tons of schist ore per day, the two-stage grinding flow sheet may be expected to produce consistently a flotation heading containing 3 to 5 per cent plus-100-mesh against 15 to 20 per cent plus-100-mesh in the single-stage flow sheet when handling 600 tons per day. When handling massive sulphide ore, a minus-200-mesh grind may be expected in the two-stage flow sheet when handling 850 tons per day.

Operations at the Utah Copper Company's Arthur and Magna plants attained in 1927 the figure of 40,000 tons treated per operating day, with an average recovery slightly over 89 per cent. During 1928, tonnage increase reached about 50,000 tons per day, with somewhat decreased extractions. During the last quarter of 1928, it became economically advantageous to increase to 60,000 tons per day, and to meet the conditions of a satisfactory grind with recoveries similar to the 1927 operation additional equipment was installed in the fine-grinding departments.

Arthur plant changed its fine-grinding flow sheet this year from a simple single-stage closed-circuit to two-stage grinding with closed-circuit secondary mills, open-circuit primaries, and preliminary bowl classifiers for the removal of primary slime of flotation size from the impact screen undersize. This change was made to secure a finer grind prior to flotation in order to increase recovery. The data indicate that with both flow sheets handling substantially the same tonnage, No. 1-A grinding to 26.93 per cent plus 100 mesh and No. 2-A to 11.73 per cent, the No. 2-A flow sheet shows a 0.11 per cent copper tailing and an 89.31 per cent recovery, against No. 1-A flow sheet's 0.188 per cent copper tailing and 81.70 per cent recovery. This improved metallurgy was obtained at an expenditure of 1.29 additional kilowatt-hour per ton milled, though the power expended in reducing section heading to 100 mesh and 200 mesh was actually less in flow sheet 2-A than in flow sheet 1-A by 0.92 and 1.41 kilowatt-hour per ton respectively.

Tests at Arthur, to determine the effect of finer grinding on recovery of copper, indicate that within the range of grinding with which they are at present concerned (9 to 15 per cent plus 100 mesh) each reduction of 1 per cent in the plus-100 mesh in the flotation heading is accompanied by approximately 0.004 per cent copper reduction in the tailing. Between 3 and 9 per cent plus-100 mesh, each 1 per cent reduction in oversize reduces the tailing loss about 0.002 per cent in copper. A balance between fine-grinding cost and extraction of copper, together with pyrite rejection, is being investigated

Table VII—United Verde

Comparative Capacities and Unit Power Consumption

	Flow Sheet 1	Flow Sheet 2			
Rated section tonnage	600	720	800	900	1,000
Mill power consumption—kilowatt-hour					
Primary mills	4,900	4,900	4,900	4,900	4,900
Secondary mills	.....	3,300	3,300	3,300	3,300
Total	4,900	8,200	8,200	8,200	8,200
Unit power consumption—kilowatt-hour per ton milled	8.16	11.4	10.3	9.11	8.2
Rated section tonnage	600	720	800	900	1,000
Tons ground per day through 100 mesh					
Primary mills	4,345	395.3	476.0	445.5	423.1
Secondary mills	.....	199.4	174.4	279.8	388.0
Total	4,345	594.7	650.4	725.3	811.1
Unit power consumption—kilowatt-hour per ton—100 mesh	11.52	14.0	12.6	11.30	10.1
Tons ground per day through 200 mesh					
Primary mills	343	306.7	358.8	354.2	326.1
Secondary mills	.....	227.5	231.2	241.0	299.3
Total	343	534.2	590.0	595.2	625.4
Unit power consumption—kilowatt-hour per ton—200 mesh	14.28	15.35	13.9	13.8	13.1

Comparative Partial Screen Analyses
Flotation Heading

Rated section tonnage	600	720	800	900	1,000
Flotation heading percent solids	.....	18	25	27	28
Percent + 100 mesh	17.2	2	3.5	5	10.5
Percent — 200 mesh	64.7	85	81.0	75	69.0

Comparative Metallurgical Results

Rated section tonnage	600	720	800	900	1,000
Heads, per cent Cu	3.36	3.21	3.44	3.38	3.56
Concentrates, per cent Cu	16.33	17.90	17.43	15.86	16.29
Tailing, per cent Cu	0.33	0.236	0.242	0.25	0.30
Concentration ratio	5.28	5.95	5.5	4.98	4.9
Recovery	92.04	93.8	94.2	93.9	93.2

Table VIII—Arthur Concentrator

Comparative Capacities and Unit Power Consumptions

	Flow Sheet 1-A	Flow Sheet 2-A
Rated section tonnage per day	2,139	2,157 (a)
Unit power consumption—kilowatt-hour per ton milled (b)	4.39	5.68
Tons ground per day through 100 mesh	806	1,141
Power consumption—kilowatt-hour per ton —100 mesh	11.66	10.74
Tons ground per day through 200 mesh	580	828
Power consumption kilowatt-hour per ton —200 mesh	16.21	14.80

(a) Tonnage this test held to same value flow sheet 1-A to show finer grind.
(b) Tube mill power only, not including classifiers, elevators and accessories.
Note:—Test results not recorded here, show lower power consumption, kilowatt-hour per ton, on greater tonnage operation.

Comparative Screen Analyses

	Flow Sheet 1-A			Flow Sheet 2-A		
	Tons	+100	—200	Tons	+100	—200
Section feed	2,139	64.63	27.35	2,157	64.63	27.35
Preliminary bowl classifier overflow	.....	.....	.....	713	5.10	81.35
Secondary classifier overflow	2,139	26.93	54.48	1,444	14.01	60.95
Combined flotation heading	2,139	26.93	54.48	2,157	11.73	66.21

Comparative Metallurgical Results

	Flow Sheet 1-A	Flow Sheet 2-A
Heads, per cent Cu	1.00	1.00
Concentrate, per cent Cu	31.00	32.00
Tailing, per cent Cu	0.188	0.11
Concentration ratio	37.95	35.83
Recovery, per cent	81.70	89.31

with a grind of 1 to 3 per cent plus-100 mesh.

Magna plant has just completed changing its fine-grinding flow sheet. Where single-stage closed-circuit grinding was practiced heretofore, this concentrator now has two stages of fine grinding, both operating with closed circuits and intermediate bowl classifiers between stages. Six sections have two mills and two single-stage classifiers in the primary circuit and six have only a single mill and a single classifier. The operating figures given are from a section having two primary mills.

The old flow sheet 1-M, when operated at high tonnage, naturally produced a coarse flotation heading and gave relatively high tailing and low recovery. At approximately 2,500 tons of section feed, this flow sheet shows a 27.94 per cent plus-100-mesh grind, a 0.188 per cent copper tailing and an 81.7 per cent recovery, against corresponding values for flow sheet 2-M of 13.09 per cent plus-100 mesh, 0.11 per cent copper and 89.31 per cent recovery, with section feed at approximately 2,800 tons.

Magna plant's grinding flow sheets, Utah Copper, Garfield, Utah

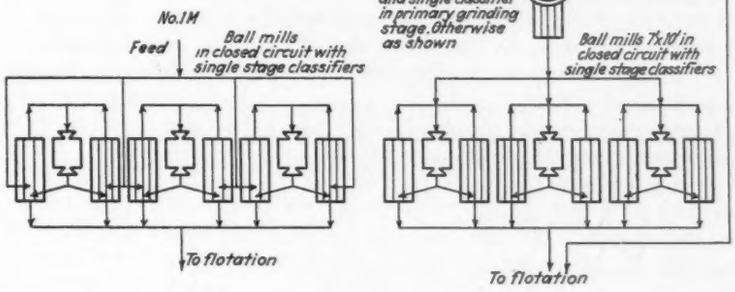

No.1M
Feed
Ball mills in closed circuit with single stage classifiers
To flotation
No. 2 M
Feed
Ball mills in closed circuit with single stage classifiers
Note: 6 sections as shown, 6 sections have single ball mill and single classifier in primary grinding stage. Otherwise as shown
Intermediate bowl classifier
Ball mills 7'x10' in closed circuit with single stage classifiers
To flotation

Table IX—Magna Concentrator

Comparative Capacities and Unit Power Consumptions

	Flow Sheet 1-M	Flow Sheet 2-M
Rated section tonnage per day	2,561	2,832
Unit power consumption—kilowatt-hour per ton milled (a)	3.53	4.88
Tons ground per day through 100 mesh	899	1,546
Unit power consumption—kilowatt-hour per ton —100 mesh	10.06	8.95
Tons ground per day through 200 mesh	642	1,186
Unit power consumption—kilowatt-hour per ton —200 mesh	14.06	11.66

(a) Tube-mill power only

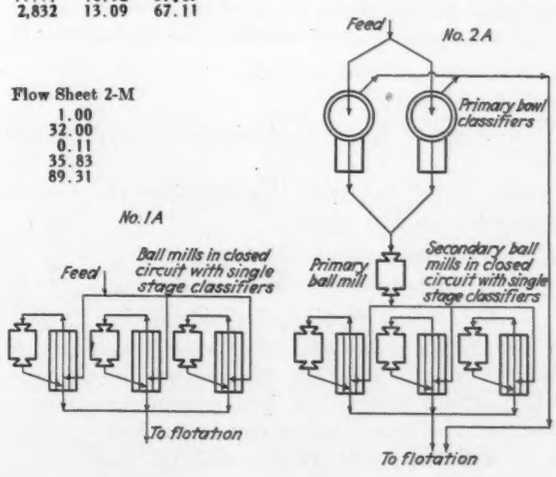
Comparative Screen Analyses

	Flow Sheet 1-M			Flow Sheet 2-M		
	Tons	+100	—200	Tons	+100	—200
Section feed	2,561	63.0	28.0	2,832	67.7	25.2
Primary classifier overflow	.....	.....	.....	.....	42.25	43.38
Intermediate bowl classifier overflow	.....	.....	.....	.....	9.16	74.94
Secondary classifier overflow	2,561	27.94	53.06	.....	16.92	57.87
Section flotation heading	2,561	27.94	53.06	2,832	13.09	67.11

Comparative Metallurgical Results

	Flow Sheet 1-M	Flow Sheet 2-M
Heads, per cent Cu	1.00	1.00
Concentration, per cent Cu	31.00	32.00
Tailing, per cent Cu	0.188	0.11
Concentration ratio	37.95	35.83
Recovery, per cent	81.70	89.31

Arthur plant's grinding flow sheets, Utah Copper, Garfield, Utah

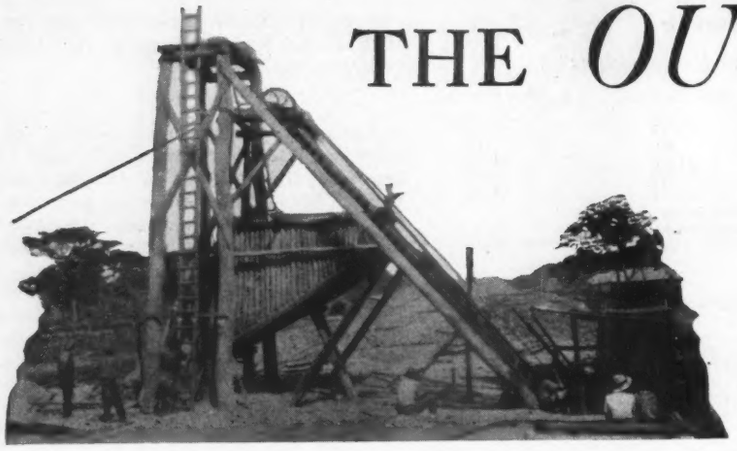


Summary

Evidently, from examining these sections, no one flow sheet can be said to represent the optimum of present practice. This is inevitable, since each concentrator has had its own particular ore-dressing problems, modified by existing plant conditions.

As a means of summarizing the conclusions drawn, however, a generalized flow sheet is attached which may be regarded as a composite picture of developments to date (see page 880). Much thought has been devoted to it. It visualizes an arrangement which perhaps might have been adopted in many of these concentrators had local conditions permitted. Data exist to prove the value of each of the steps of this flow sheet at one or more concentrators. That this arrangement will soon be antiquated is of course probable. The composite picture may, however, offer a good basis for such discussion as may follow, and perhaps may serve as a stepping stone for further improvements in fine-grinding practice.

THE *OUTLOOK* FOR T



A development headframe at Roan Antelope

OWEN LETCHER
Johannesburg, Transvaal

THE financial aspects of the Northern Rhodesian copper field, and the questions of eventual capitalization and dividend distribution, as well as of outputs and tonnages, are problems upon which it would not be discreet to express definite opinions at present. To attempt dogmatic estimates probably will be unwise for a number of years to come, and it will certainly be rash to attempt exact calculations until the industry is in its productive stride.

Taking the price of copper at £70 per ton, each 1 per cent of metal recovered is the equivalent of 14s. On a basis of 3.5 per cent ore and a recovery of 90 per cent, the sterling value per ton therefore works out at 44s. 2d.

A plant treating 5,000 tons per day working full time throughout the year and recovering 90 per cent of a 3.5 per cent ore would produce 57,487 tons, worth £4,024,090. Assuming production costs to be £45 per ton of metal, the resultant profit on a 5,000 tons per day basis would be slightly over £2,000,000 per annum. These are merely tentative figures, which, in the absence of more definite or exact data, are suggested as approximate figures to be applied to estimates relating to tonnages with reference to grade.

That in these estimates there are factors which are of indeterminable values is plainly apparent.

THE PROBLEM OF WORKING COSTS

Tonnages, grade, and plant capacities can within certain reasonable margins be assessed. But the following factors, which are obviously of the very greatest importance in determining the equation of working profits, can at present be estimated only with considerable qualifications:

(*a*) The future price of copper.

(*b*) Working costs.

(*c*) Percentage of recovery obtained by metallurgical plants.

(*d*) Total capital expended by the time the profit-earning stage is reached; and

(*e*) Period of time which will elapse—

1. Before production is reached
2. Before distribution of dividends is attained.

There are in addition, obviously, other data, such as life of the mines in question and amounts which will have have to be paid out in taxation, before even approaching an estimate of real share values can be arrived at. No attempt to estimate such values will be made here, but a few comments may be ventured on some of the indeterminable factors above mentioned.

With regard to (*a*) *Price of Copper*—The most reliable information available relating to production, stocks and consumption is encouraging. The weight of data is favorable to the view that the price is likely to be maintained.

Companies and individuals who play a leading part in the marketing and price control of copper throughout the world are largely interested in the Northern Rhodesian fields. They have spent millions of pounds on the initial development and equipment of these mines and they are prepared to spend many millions more. That they would involve themselves so heavily in Northern Rhodesia if they considered that any very serious threat to copper prices was imminent is unlikely.

(*b*) *Working Costs*—It is extremely difficult—in fact almost impossible—to venture reliable figures as to what the level of working costs over the whole field or in any individual mine is likely to be. In the opinion of several engineers who have recently visited the fields, however, an estimate of £45 per ton of copper produced is considered to be reasonable, and assuming this to be the cost of production of metal on a basis of 3½ per cent ore and 90 per cent recovery, working costs work out at 28s. per ton of ore treated. There is not very much to guide us in endeavoring to arrive at an estimate as to cost of production when very big copper tonnages are involved. Neither costs in the Congo nor those of the old Bwana mine afford any valuable criterion. The Rand probably affords a fairer comparison, and costs as calculated above are over 8s. per ton higher than those of the Rand.

Considering the immensity of the Northern Rhodesian orebodies, the much shallower depths of working, and, so far as is at present known, the absense of phthisis at these mines, it would seem fair to suppose that mining costs in Northern Rhodesia should be substantially less than on the Witwatersrand.

The lesser rates of pay for native labor (15s. to 20s. per month as against 58s. on the Rand) should also tend to make mining charges less in the north than on the Main Reef Series. On the other hand, native labor efficiency on the Witwatersrand is considerably higher than on the Northern Rhodesian Copper Belt. European wages at the copper mines are on the average higher than on the Rand. Freedom from phthisis will in the earlier stages be offset to some degree by the incidence

THE NORTHERN RHODESIAN COPPER FIELDS

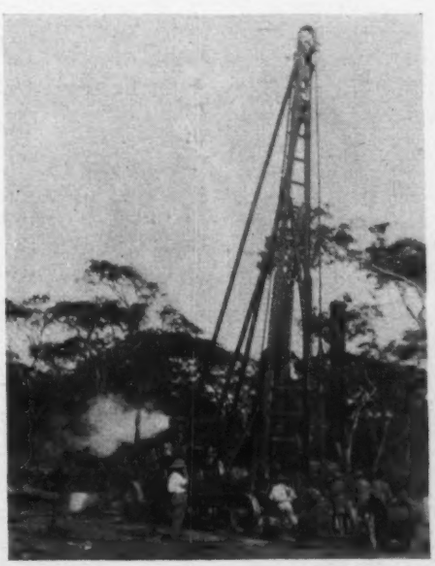
of malaria. On the Northern Rhodesian fields there will be a tendency for native labor efficiency gradually to increase, and synchronously rates of native labor pay will move upward. With the completion of the line from Katanga to Lobito Bay, the building of the Kafue-Sinoia line (which is certain to be undertaken in the near future) and the growth of volume of traffic, there will be a tendency for railway rates to decrease, and this will have a favorable influence on the cost of stores and supplies. Agricultural products will become of better quality, and price levels for maize, meat, and other produce will show a tendency to decline as more and more acreages are put under cultivation. Taken on the whole, therefore, the level of working costs in Northern Rhodesia should tend toward reduction, and a year or two after large-scale production has commenced, working expenses should be substantially less than in the first year of output.

(*c*) *Percentage of Recovery Secured by Metallurgical Plants*—According to results secured from the pilot plant at Roan Antelope, this will vary between 85 per cent for oxidized ore and 95 per cent for straight sulphide ore. Mixed sulphides and oxides such as occur at N'Changa and in some other parts of the copper field will present some metallurgical difficulties, but an improving percentage of extraction for ores of this nature should be secured as production gets into full swing.

(*d*) *Total Capital Expenditure*—To bring Roan Antelope, N'Kana, Mufulira, Chambesi, and N'Changa to production on the bases of capacity contemplated, a further sum of not less than £20,000,000 will have to be provided during the next five years. By the time these mines are working at full capacity other properties will be developing, and by 1934 the total capital expenditure incurred by the various copper mines and concessionary companies (including expenditure up to the present date) will probably be nearly £35,000,000.

(*e*) *The Time Factor*—A most important point in connection with Northern Rhodesia share values and prices is the period of time that will elapse before any dividend return can be expected from actual productive operations. Copper production on a huge scale is a phase of mineral activity which is almost entirely foreign to Southern Africa, where really large-scale production has hitherto been confined almost entirely to gold, diamonds, and coal.

Churn drilling at Chambesi Mine



The immensity of the Northern Rhodesian copper deposits fully warrants preparations for the mining and treatment of something like 20,000 tons of ore a day, and to achieve this the five big mines so far discovered and to some degree opened up will, as already stated, have to spend during the next few years £20,000,000 on development and equipment of these properties.

Such projects not only mean the disbursement of huge sums of money, but obviously a very considerable period of time must elapse before the necessary development is completed and concentrators, smelters, workshops, stores, and power plants are in commission.

The opening up and equipment of a large copper mine is both a lengthy and a costly business and it is generally assumed that at least four years must elapse at Roan Antelope before both mine and mill (including smelter) are ready.

The most advanced mine in Northern Rhodesia—most advanced in regard to both development and equipment—is the Roan Antelope, and that the productive stage will be reached here until 1931 is not considered probable. N'Kana will be the next really big mine on the list to produce copper, but N'Kana is some considerable way behind the Roan and it is generally understood that N'Kana will not be producing until 1933. The dates of commencement of outputs at Mufulira, N'Changa, and Chambesi are uncertain. Some form of shrinkage stoping on a huge scale will be the method of mining adopted at most of the Northern Rhodesian mines. This will mean the blocking out of large tonnages of ore with the object of having an ample and assured supply for the plant.

In some quarters it is contended that development and equipment of these vast copper mines of the north could and should be accelerated. Time means money, and in view of the enormous sums already locked up and to be locked up in the Northern Rhodesian copper mines, acceleration of development and equipment would

Typical scene along the Roan Antelope outcrop

imply huge savings in respect of interest on capital invested.

Certain limitations will retard progress, and will be difficult to remove, however insistent the demands for acceleration may be. The sinking of shafts and establishment of other main points of attack and development, and the securing of an adequate number of stope faces to furnish an unfailing supply of ore, will necessitate an adequate complement of trained native laborers. Such a force cannot be trained in a month, or even in a year. The carrying capacity of the existing railways will further limit progress. Huge quantities of heavy plant equipment will have to be shipped from England and America and transported over a single-line railway system that is already severely taxed to cope with the increasing traffic of the north as well as the trade of Southern Rhodesia. Even if the Kafue-Sinoia cutoff were commenced immediately, and every effort were concentrated on accelerating completion of this line, the new railway could hardly be finished in time to assist in any material degree the period of heavy plant construction. The link to connect the Congo system with the Benguela Railway is expected to be completed by July, 1931, and the Lobito Bay exit should then afford the much-needed relief. That everything possible and practicable will be done to speed up development and equipment and to reach production at as early a date as possible can safely be assumed, but taking everything into account it is extremely doubtful whether material reduction can be effected in the time occupied in bringing the mines to the productive stage.

The ramifications of all this mineral development in South Central Africa are certain to have reactions of a most important nature throughout the whole of the sub-continent and indeed much further afield. It does not seem improbable that in about seven years' time the Northern Rhodesian mines, together with those of Katanga, will between them be producing as much as 25 per cent, perhaps even more, of the world's output. To secure such a production, no less than £20,000,000 will be expended on capital account in Northern Rhodesia alone in addition to expenditure to date, and expenditure on new mines. It is not unlikely that the Union Minière will spend another three or four million pounds on the construction of a leaching plant unit at Chituru and on the development and equipment of the Musinoi or Western Group of mines. In all, then, a sum of about £25,000,000 will probably be spent upon capital account, for development and equipment in this richly mineralized area. Over and above all this, there is of course the vast amount of money that will be spent on ordinary working account when production is begun.

Do manufacturers realize the immensity of the market that is arising in this portion of Africa which less than half a century ago was the domain of the slave traders, a region of pristine Africa closely guarded by all the forces of savagery and barbarism and tropical disease? Do they appreciate the immense spending capacities of these mines and of the fast growing communities which derive their livelihoods from these mines? Do agriculturists in Rhodesia and throughout Southern Africa generally realize the immensity of the market for foodstuffs to feed the huge complements of natives that will be required, and also the thousands of European mouths that will demand their daily "bread"? Again, do makers of agricultural machinery, of plows, hoes, fencing, and other implements, generally realize that many scores of thousands of pounds will be spent on the purchase of such items in order to make the fertile lands of Northern Rhodesia yield their maximum harvest?

Take the transportation question, for example. Until all this new mineral development on the British side of the frontier was initiated, and a magnified industrial success was assured, Rhodesia generally and the railways of Rhodesia in particular existed under the threat of losing the vast trade of the Congo when the Benguela Railway was completed and the magnificent harbor of Lobito Bay and the Atlantic seaboard was linked up with the great mineral belt. The opening up of the Northern Rhodesian copper fields has removed this Sword of Damocles.

In the course of the next few years the mineral industry of Northern Rhodesia and the Congo is going to assume such immense proportions that all the transportation systems completed and projected will be fully taxed to cope with the immense volumes of incoming and outgoing traffic. That is to say, the existing Rhodesian Railways plus the Kafue-Sinoia cutoff line (which will almost certainly be constructed within the next five years), the Benguela Railway, the Bas Congo Katanga line, and the route across Lake Tanganyika and down the Central Railway line to Dar-es-Salaam will all be required in order to cope with exports of metal and imports of stores, supplies, and machinery.

In addition to the existing branch lines and those under construction in Northern Rhodesia, the Roan Antelope branch, the N'Kana branch, and the Mufulira-Mokambo branch, other lines will most certainly have to be built. There will be an extension of the N'Kana line through Chambesi to N'Changa, and in the course of time a prolongation of this railway toward Mwinilungu and Kansanshi will probably be constructed.

Already there is talk of eventually linking up the Northern Rhodesia fields with the Benguela Railway in

Angola, thereby cutting off two sides of a triangle (N'Dola-Tshilongo and Tshilongo-Benguela Railway) and bringing the heart of the Northern Rhodesian copper fields within eleven hundred miles of the Atlantic seaboard.

In addition to railways there will be a tremendous development of road-motor services. The "Tenga Tenga," or native porter, has already practically disappeared from South Central Africa, where but a few years ago "Ulendos," or caravans of "boys," with heavy loads trudged along native paths. The motor car and lorry now dash along broad roads. In this respect, also, there is a highly profitable market awaiting the industrialists in Northern Rhodesia. Already, Elisabethville and N'Dola possess a remarkably high car ratio—that is to say, of cars in relation to population—and hundreds of thousands of pounds will be expended in cars and lorries, tires and accessories, and petrol and oil during the next few years. Contemplate the shipping services that will be necessary to cope with all the copper to be exported and all the machinery and stores and supplies of all kinds that will be imported into the country. Exports alone—500,000 tons of copper yearly—will call for many thousands of tons of shipping. Lobito Bay is destined to become one of the great ports of the Southern Hemisphere, but in regard to harbors with railways I do not think that there need be much fear as to insufficient traffic to keep both the Atlantic and Indian Ocean seaboard routes busy. In other words, Beira is not likely to find itself and its new harbor equipment relegated to inactivity because of Lobito Bay. There will be enough traffic to keep all the cranes and lightering and loading appliances of both these harbors fully employed, and in addition there is likely to be quite enough inward and outward traffic to make Matadi, at the Congo mouth, and Dar-es-Salaam, on the Indian Ocean, busy ports for Central African trade.

The opening up of this copper belt will also have political repercussions of importance. It has been mainly upon the basis of copper that the Congo has so rapidly emerged from barbarism and in its development and wealth has so rapidly outdistanced the possessions of all other Continental nations in Africa.

Northern Rhodesia, also because of copper, is to become a state of dominating importance amongst the British territories situated to the north of the Limpopo River. A few years ago Northern Rhodesia could have been induced to join forces with Southern Rhodesia upon almost any reasonable terms that Southern Rhodesia might have cared to offer. The position is now reversed. In a few years' time Rhodesia north of the Zambesi River is fairly certain to possess a greater white population and a greater revenue than her sister dependency. Northern Rhodesia's political destiny is more likely to shape along lines which will mean absorption of Nyasaland, with its dense native population, rather than union with Matabeleland and Mashonaland. Northern Rhodesia's development will strengthen Rhodesia's resistance to the Union's influence from the south. There is to be a new and more central and healthier capital of Northern Rhodesia. It will probably be situated near N'Gwerrere, on the highlands north of the Kafue River. This new African town—it may perhaps be called Cecilia, in honor of the country's founder—will be a vastly important point in the whole body, politic and economic, of South Central Africa. From these administrative fields will go forth feats that will mold the destinies of this African possession of Great Britain and of adjacent territories as well. Two hundred and fifty miles away to the north, another town, N'Dola, will become the Johannesburg of Central Africa, the Butte of the British Empire. It is an engrossing subject—this survey of a region that has within the last year or two been transformed from the domain of the elephant hunter, the government official, the missionary, and the trader, into the realm of the industrialist, with the assured promise of becoming one of the world's greatest mineral producing countries. In contemplating it let us not forget to pay homage to those pioneers of statesmanship, of adventurous expenditions, of finance and technology who have founded it.

Number 2 shaft, N'Kana mine

Assembling a headframe at Roan Antelope

COMMENT AND CRITICISM

Air Preheating in Zinc Oxide Processes

To the Editor of "E.&M.J.":

In your issues of Sept. 7 and Nov. 9 I read with interest the description of the Follsain process, using Philipon superheaters, as applied to low-grade zinc blendes. From the data I gather that the Follsain process treats low-grade ores in a rotary furnace, applying highly preheated air instead of air of atmospheric temperature, in contrast with the Waelz zinc oxide process. The application of highly preheated air is an interesting improvement, as it will allow a high reaction temperature (1,600 to 1,800 deg. C.) and thus will be followed by the acceleration of the desired reactions. Time and fuel will be saved. The reaction zone in the furnace, at a higher temperature than in the other known oxide processes, will be more concentrated, allowing reduction of furnace length.

The metallurgical treatment of low-grade zinc ores, often called zinc oxide processes, is nothing more than a fire method of concentration. In present practice, the low grade of these ores necessitates low treatment charges. The main cost in fire concentration is the expense for fuel, so any method to accelerate the reactions and recuperate waste heat is of highest interest.

It is not stated whether air preheating is performed by direct firing or from waste heat. If by direct firing, experience has to prove if the acceleration of the reactions will offset the cost. Applying highly preheated air will produce in the furnace a high-temperature zone where residues will easily be slagged and liquefied, a condition not desired in most of the oxide processes. Accretions are easily formed, with all the trouble to clean them out of the furnace. With most zinc ores, sintering and slagging of the residue must be avoided, if high recovery is desired and high recovery, with low-grade ores, is essential for successful commercial operation.

The Philipon superheater should find wide application, also, as a waste-heat recuperator when medium temperatures are considered. But for waste heat with 1,000 deg. C. and above, I am in doubt as to whether metal superheaters or metal recuperators can stand long service. The combination of firebrick and metal recuperators will be of interest. A firebrick recuperator of a type less known on this continent is the Hecker recuperator (U. S. Patent No. 1,426,-381). It is on the strong countercurrent principle, cheap and quick to assemble, practically tight, sustaining high air pressure, and has given long service under unfavorable conditions. With its use, air preheating up to 1,000 deg. C can be obtained without difficulty.

G. Ross.

Monterey, Mexico.

Dr. Houghton's Monument

To the Editor of "E.&M.J.":

Built of native rocks of the rugged upper peninsula of Michigan, in which he pioneered and suffered hardships that its vast, rich mineral resources might become known to the world, what more appropriate monument could have been erected to the memory of Douglass Houghton, Michigan's first state geologist? Unusual in strength of design and purpose, picturesque and inspiring, it stands opposite the spot where Dr. Houghton sacrificed his life through drowning off Lake Superior, off Eagle River, Keweenaw County, on Oct. 12, 1845. He was then only 36 years of age.

The monument was erected by the people of Houghton and Keweenaw counties. Houghton County, in which are some of the world's greatest copper mines, including the famous Calumet & Hecla, was named in honor of the distinguished geologist.

Greenstone or traprocks, predominant in the upper peninsula of Michigan, are largely used in the monument. In addition, there are hematite ores from Ishpeming, marble from Manistique, granite boulders, sandstones, limestones, slates, and rocks from practically all the lodes and float rocks found in the Lake Superior copper district.

At the southwest corner is a rock from the famed Calumet conglomerate lode of Calumet & Hecla; at the southeast corner, an Osceola amygdaloid rock; at the northeast corner, an Ahmeek or Kearsarge amygdaloid rock; and at the northwest corner, a rock from the Ashbed lode of the old Phoenix mine.

The large trap or greenstone cap was raised from the bed of Eagle River by the Keweenaw Copper Company and placed in position on the prepared foundation. The monument site was presented by Calumet & Hecla.

M. W. Youngs.

Houghton, Mich.

Douglas Houghton Monument at Eagle River, Mich. Note the various Michigan geological formations.

Sir Joseph Wilson Swan's Electric Lamp

To the Editor of "E.&M.J.":

In reading your editorial on "Light's Golden Jubilee" in your issue of Nov. 9 I was disappointed to find that the name of J. W. Swan was not even mentioned in the course of your remarks. In the "Encyclopedia Britannica" I find the following:

"In the year 1860 Sir Joseph Wilson Swan produced an electric lamp with a carbon filament, which was formed by packing pieces of paper or card with charcoal powder in a crucible and subjecting the whole to a high temperature. The carbonized paper thus obtained he mounted in the form of a fine strip in an evacuated glass vessel and connected it with a battery of Grove's cells, which though not strong enough to raise it to complete incandescence were sufficient to make it red hot. This was substantially the method adopted by Edison twenty years later. Subsequently Swan devised a cotton thread 'parchmentized' by the action of sulphuric acid, and on the twentieth of October, 1880, he gave at Newcastle the first public exhibition on a large scale of electric lighting by means of glow lamps."

Thus the production of a commercially successful electric glow lamp by Edison and by Swan was so nearly simultaneous, though admittedly independent, that even if there be any controversy as to exact priority of date (a point I am not conversant with, and difficult, I suppose, to fix accurately), it seems to me that the name of Swan should go down to posterity indissolubly linked with that of Edison in any reference to the invention of the incandescent system of electric lighting.

E. M. Hamilton.

San Francisco, Calif.

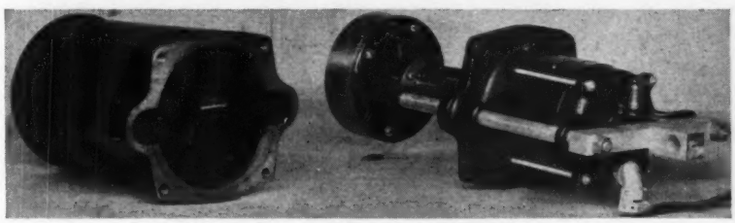
INDUSTRIAL PROGRESS

Substitute for Solenoids and Air Cylinders Introduced for Operating Doors and Brakes—Other Equipment

AMONG equipment recently brought to the attention of the editor are several devices and machines from electrical manufacturers, in particular a vertical-type, two-stage turbo generator of large capacity. Of special interest to the mine operator is the following:

An "Hydraulic Operator"

An interesting industrial control device known as the hydraulic operator has been developed by General Electric. It is intended to take the place of large alternating- or direct-current magnets and solenoids and may also be used to replace air cylinders where quiet and smooth upward thrust is desired through a given distance. It consists of a motor-driven centrifugal oil pump, the impeller of which is mounted in a piston and is driven by means of a spline shaft. The arrangement permits the stationary mounting of the motor. Normal position is with the piston at the bottom of the cylinder, which is approximately two-thirds full of oil. When energized the motor drives the impeller, creating a pressure between the bottom of the piston and that of the cylinder.



"Hydraulic operator" with oil tank removed

The piston is cast so that the oil is fed to the center of the impeller from top and bottom. The oil is forced from the end of the impeller blades through ports to the space below the piston. Pressure tends to move the piston upwards, and the latter will travel the full length of the cylinder provided the load on the ends of the push rod is not too great. These operators may be had in three standard sizes, giving, respectively, a push of 200, 300, and 600 lb. Operating speed is slower than that of a solenoid, but is relatively fast. The motors used are small, $\frac{1}{4}$ to $\frac{1}{2}$ hp., and therefore rapidly come up to speed. The time required to raise the piston depends upon the diameter and speed of the impeller, diameter and length of the cylinder, and the load to be lifted. Owing to the stored energy in the revolving parts the downward movement does not start until 0.3 sec. after the motor is de-energized, and that is with maximum load. Inasmuch as the oil must be forced back through the revolving impeller blades as dashpot action results, 0.8 of a second is required for the total downward travel.

This device is intended for application to brakes, clutches, door and window openers, spot welders, pumps, and other places where solenoids and air cylinders are now employed.

New Welding Equipment

Additions to three lines of welding equipment have been recently announced. One of these is the new dual-drive arc-welding unit introduced by Westinghouse. This consists of a standard 300-amp., single-operator welding generator, a 15-hp. a.c. induction motor, and a six-cylinder, 1,800 r.p.m. Continental gas engine, all mounted in tandem on a structural steel base. The motor runs on 220 volts, but by changing the leads and the line-starter coil can be used on 440 volts. The generator can be driven by either the gasoline engine or the electric motor by simply engaging or disengaging a slip coupling or clutch. This machine may be had in all the popular single-operator ratings.

For gas welding a two-stage oxygen regulator, designed to eliminate fluctuation in working oxygen pressures, has been introduced by the Oxweld Acetylene Company, New York. The chief feature of this regulator, which is designated as Type R-109, is two-stage pressure reduction, which is accomplished through the medium of two independent sets of diaphragms, valves, and springs. The full cylinder pressure of about 2,000 lb. per square inch is reduced to working pressure in two stages instead of one stage. In the first stage, the cylinder pressure is reduced through a non-adjustable reducing valve to about 175 lb. per square inch. In the second-stage, reduction is made to the working pressure, which may be only a few pounds per square inch, by means of a hand wheel. When the pressure in the cylinder falls below 175 lb., the first-stage valve remains fully open.

The fourth piece of welding equipment of those referred to is an automatic idling device, or throttle control for regulating the speed of engine in the "Stable Arc" welders of the gasoline-engine-driven type put out by Lincoln Electric Company, Cleveland. The new device automatically increases the speed of the engine from normal idling to proper speed for welding whenever the arc is struck. When welding is stopped, the device automatically reduces engine speed to normal idling. The operating mechanism of the device consists principally of a small metal bellows and an electric magnet.

Headlight More Efficient

A new headlight resistance, which will make individual units more efficient and more easily maintained, has been introduced by Ohio Brass for electric railway and mining service. All units of the resistance are of the exposed-wire type, which operate at comparatively low temperatures, in contrast to the covered-wire type, which greatly reduces radiation and results in much higher operating temperature. The wire is of nickel-chromium composition and is proof against corrosion or brittleness on long use. The tubes which support the wires are threaded to remove the possibility of the individual turns short-circuiting. These tubes are arranged side by side, so that heat given off from one cannot strike another. Ventilation is afforded by two baffles, mounted on

This headlight resistance is said to be efficient and easily maintained

top of the resistance and forming a duct for air circulation. These also keep the heat of the tubes from rising to the surface on which they are mounted. To make up for possible variations in line voltage, a sliding shunt is attached to two adjacent tubes. No operating parts are exposed in the new resistance. If, after long service, it becomes necessary finally to replace a tube, this can be done quickly without disturbing the others. This new (Form D) removable unit resistance may be had for all voltages.

This Endless Belt Novel

A new design of endless-cord transmission belt, known as the Compass, has been introduced by Goodyear Tire & Rubber Company, of Akron, Ohio. It differs from ordinary fabric belts, made endless with a splice, in that it has no splice in the core of cords which carries the load. The cords are imbedded in rubber and covered by an elastic rubberized fabric envelope, which takes all of the surface wear. Since it is elastic, all of the load is properly thrown on the cords. According to the manufacturer, the belt is practically stretchless, extremely flexible, and much thinner than belts of previous designs, but it is of equal power capacity. It is recommended for drives on such equipment as compressors, vacuum pumps, rock drills, and other high-speed small-pulley drives.

An Auxiliary Lighting Plant

To meet a growing demand for a dependable source of power to supply illumination in cases where it is uneconomical to operate the main prime mover, Fairbanks-Morse & Company has developed a compact self-contained light plant that is simple and reliable. Particularly is this unit adaptable for use on cranes, dredges, and excavating equipment.

Generally it is not feasible to operate a lighting generator from the main power unit, because of the extreme speed variations due to radical load fluctuations, which occur on this unit and consequently cause violent voltage fluctuations, which in turn produce a bad flicker in the light. An independent lighting unit provides a steady candle power.

The plant comes in two sizes of 750 and 1,500 watts' capacity. In the assembly, the power unit, ignition system, generator end, and control mechanism are maintained as separate units. Engines used are the Fairbanks-Morse self-oiling "Z" units with high-tension magneto ignition. The smaller, a 1½-hp. unit, is designed to run on gasoline; the larger 3-hp. engine can use either gasoline or kerosene.

The generator has ball bearings and is mounted directly above the engine, to which it is connected by a "V" belt drive. Its control mechanism is contained in a completely inclosed box mounted as a unit on the main frame, and consists of a push-button start and a high-low-belt switch which permits the storage battery to be charged at a rapid rate for regular charges or a low rate for an equalizing charge.

In the "belt" position, the generator is electrically disconnected from the engine, so that the entire power output is available for mechanical work from a pulley on the engine shaft. The storage battery plant starts with a simple push-button control, the generator acting as a motor during the starting period, no cranking being required. Ignition is furnished by a high-tension rotary magneto.

The plant is water-cooled by means of a radiator and a fan and water circulating system similar to that employed by any automobile engine. Air cooling of the radiator is also arranged to provide for cooling of the generator. The accompanying table gives some of the more important specifications:

Size plant, watts	750	1,500
Horsepower	1½	3
Bore, in.	2½	3½
Stroke, in.	3½	5
R.p.m.	1,500	800
Fuel tank capacity, qt.	3	8
Lubricating oil capacity, qt.	1	1
Water capacity, gal.	1½	2½
Power pulley		
Diameter, in.	4½	6
Belt width, in.	3	4
Speed, r.p.m.	750(a)	800
Generator		
Power rating, watts	750	1,500
Volts	32 or 115	32 or 115
R.p.m.	3,600	3,000
Charging rate		
At 32 volts, amp.	18–22	34–42
At 115 volts, amp.	5½– 6	11–13
Floor space		
Height, in.	25½	30½
Width, inc. crank, in.	23½	30½
Length, in.	26	32
Shipping weight, lb.	275	500

(a) Half engine speed.

Although this plant is built in two sizes, it is offered with a variety of storage-battery combinations which will meet almost any demand placed on the unit for either a 32-volt or standard 115-volt circuit.

New Quiet-Running Motors

General Electric announces a line of single-phase, squirrel-cage capacitor motors (Type KC), especially designed for quiet operation. These are expected to find their principal application driving blowers and ventilating fans in buildings, on low-torque centrifugal machinery on low-pressure pumping applications, on some woodworking machines and on machine tools where the motor is built into the machine.

Although classified as a single-phase machine, the motor is really a modified two-phase, squirrel-cage motor with a capacitor in series with one phase of the stator windings. This gives starting characteristics similar to the two-phase, squirrel-cage motor; that is, it is self-starting. The capacitor remains in the circuit throughout starting and running, so that full-voltage hand or magnetic control only is required. As a result, single-phase pulsation is absent. In addition, special slot combinations and rotor construction are used to obtain an even greater degree of quietness during operation.

The ratings available in the new line are from 1 to 25 hp., inclusive, at 3,600, 1,800, 1,200, and 900 r.p.m. constant speed, with starting torque from 60 to 40 per cent of full-load running torque, depending upon speed. Maximum torque is approximately 200 per cent of full-load running torque.

A New Vibrating Screen

According to tests made by the U. S. Bureau of Mines to determine the effect of sieve motion on screening efficiency, highest efficiency is obtained when the sieve is agitated by a high-frequency vibratory motion. A recent development in so-called "high-frequency" vibrating screens is one of the positive eccentric-throw type, known as the "Vigger." The screen body is mounted upon rubber disks which in turn are secured to a tiltable framework. This pivots about a shaft which runs beneath the frame and which carries the eccentrics and two heavy flywheels. The flywheels confine the vibration to the screen itself, while the eccentrics cause the vibration.

From time to time, in order to meet conditions imposed by a particular screening problem, it is necessary to find the most effective combination of angle, amplitude of throw, speed of vibration, and direction of rotation. With this screen the angle may be changed, as noted, to 50 deg. from the horizontal, even while the screen is in motion. Eccentricity is variable at will, from $\frac{1}{16}$ in. to zero, the change being accomplished by rotating the eccentric upon the drive shaft, which is itself eccentric. Speed and direction of rotation are easily changed, as most screens of this type are driven by individual motors.

The new screen uses cloths of 1-, 2-, 3-, and 4-ft. widths, held in by a method which requires no special framework and which permits of taking out the old cloth and replacing it in less than 15 min. The design is such that the screen is noiseless.

Four standard sizes are made, 1x3 ft., 2x5 ft., 3x8 ft., and 4x8 ft. Additional decks, up to a total of three, may be easily added. The makers are the Productive Equipment Corporation, 7535 South Claremont Ave., Chicago, and 30 Church St. (export office), in New York City.

New Turbo Generator Most Modern

What is called by its builder the most modern turbine generator thus far conceived is to be installed by the Ford Motor Company at its River Rouge station. This machine, rated at 110,000 kw., involves various interesting departures in design and construction. It is a vertical compound unit and is the first large machine to be thus made. The high-pressure turbine and generator will be mounted directly on top of the low-pressure unit, making it the most compact installation yet proposed. Each element has a capacity of 55,000 kw.

The installation will be one of the first important units designed to use steam at a pressure of 1,200 lb. exclusively. Marked economy in coal will result. Less than 1 lb. of coal per kilowatt-hour will be required.

Compactness of the new unit is demonstrated by the following: Floor

space occupied is 57 ft. 6 in. by 23 ft. Over-all height is a little less than 21 ft. Approximate weight is 2,000,000 lb. Less than a quarter of a cubic foot of space will be required per kilowatt of output. The unit will occupy the space previously taken by two units generating a total of 25,000 kw.

The machine has been designed and is being built by General Electric at Schenectady and will be placed in operation in 1930. Its complete technical rating is 110,000 kw., 90 per cent power factor, 13,800 volts, 1,800 r.p.m., 3 phase, 60 cycles, with steam conditions of 1,200-lb. gage pressure; 725 deg. F. total temperature; re-heat to 550 deg. F., and 1 in. vacuum. Steam will enter the upper turbine unit at 1,200 lb. and after producing 55,000 kw. will flow into re-heaters. In these steam at 1,200 lb. direct from the boilers will reheat the steam exhausted, which will then flow down and into the low-pressure unit. All coolers built integral with the generators will be so connected that heat losses in the latter will be recovered and returned in the feed water.

Another Hard-facing Alloy

A new hard-facing alloy, known as Borod, is being marketed as a welding rod by the maker, the Stoody Company, Whittier, Calif. Its application requires no more preparation or processing than any welding operation. The deposit from it, however, is said to be unique in character, having characteristics of pure tungsten carbide in so far as surface hardness and resistance to abrasive wear are concerned, although actually an alloy of tungsten and iron, intermingled with a certain proportion of pure iron, which acts as the solvent for minute particles of tungsten carbide. When fractured, the deposit has all of the granular appearance of a fine grade of tool steel, yet will test from 65 to 70 on the C scale of a Rockwell hardness testing machine, according to the manufacturer, and will resist abrasion as well as pure tungsten carbide.

Regardless of the extent or shape of the area to be hard faced, this welding rod leaves a continuous deposit which has a smooth, even surface, no matter whether it be applied with the electric welding arc or the oxy-acetylene flame. These properties make possible the overlaying of surfaces heretofore considered unsuitable for such processing. Borod is believed to be the first material of record by which a quite pure tungsten carbide overlay may be applied quickly, easily, and economically by anyone familiar with welding.

Gas Mask Improved

Bullard-Davis, Inc., has developed a new (Red-D) rubber face piece for its gas masks. The new rubber has a marked tendency to hold its shape. It resists abrasion better. Upon a rigid aging test it shows remarkably long life. Another improvement is the exhalation valve, which is set at right angles well up under the chin, so that it does not interfere with head motion in any direction.

For Electric Shovels

The plug and receptacle shown in the accompanying cut has been designed by Albert and J. M. Anderson Manufacturing Company, Boston, Mass., for the Marion Steam Shovel Company, for use on electric shovels to be furnished to the Belgian government in the Congo. It is rated at 5,000 volts 100 amp. When the plug is inserted in the receptacle, the unit is 21 in. long and weighs 62 lb.

INDUSTRIAL NOTES

Cutler-Hammer, Inc., has removed its St. Louis district office from 611 Olive St. to 1914 Washington Ave., St. Louis, Mo.

Wagner Electric Company, of St. Louis, Mo., has designated D. O. Reardon as Iowa representative, with headquarters in Des Moines.

Allis-Chalmers Manufacturing Company, of Milwaukee, Wis., has appointed T. B. Woods Sons Company, of Chambersburg, Pa., as special distributors for Texrope drives.

General Refractories Company, of Philadelphia, Pa., announces the appointment of the Harris Pump & Supply Company, of Pittsburgh, Pa., as representative in the Pittsburgh district.

Mancha Storage Battery Locomotive Company, of St. Louis, Mo., has appointed E. H. Gibbes as Eastern sales manager, with headquarters in New York City.

Bullard-Davis, Inc., announces that the "Hard Boiled Hat" has been approved by the Pennsylvania State Department of Mines, and by the underwriters' laboratories, for use as head protection.

Pratt-Gilbert Hardware Company, of Phoenix, Ariz., announces the election of C. E. Gollwitzer to the position of secretary and director, effective immediately, to take the place of P. R. Helm, who has resigned.

Joseph T. Ryerson & Son, Inc., has appointed A. C. Allshul, formerly manager of the Buffalo, N. Y., plant, to the position of manager of the company's new unit in the Philadelphia district. C. S. Gedney succeeds Mr. Allshul at Buffalo.

Hercules Powder Company announces that J. J. Kelleher has become associated with its contractor's division, explosives department. His headquarters will be at the home office of the company, in Wilmington, Del. J. R. St. Clair, formerly of the sales force of the Duluth, Minn., office, has been transferred to the technical service staff attached to the Wilmington office.

Westinghouse Electric & Manufacturing Company announces that Thomas Fuller, formerly manager of the Charlotte, N. C., office, has been appointed manager of the Atlanta district office to fill the vacancy caused by the death of H. A. Coles.

Baker & Company, Interstate division, 54 Austin St., Newark, N. J., announces that The Interstate Smelting & Refining Company, also of Newark, has been taken over completely by the Baker organization, and that all mail should be sent to the above address.

BULLETINS

INSTRUMENTS—Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa. Catalog No. 86. Optical pyrometers.

COMPRESSOR—General Electric Company, Schenectady, N. Y. Bulletin No. GEA-1119. Reciprocating air-compressor sets, single-stage, stationary.

PUMPS—The Connersville Blower Company, Connersville, Ind. Bulletins No. 6A and 19E. Describe the company's priming centrifugal and cycloidal rotary pumps.

SWITCHES—General Electric Company, Schenectady, N. Y. Bulletin No. GEA-83-A. Describes CR7009-B5 and -B6 inclosed magnetic reversing switches.

WELDING—Alloy Welding Processes, Ltd., Ferry Lane, Walthamstow, London, E.17, England. "Operators' Handbook on Electric Arc Welding."

INSTRUMENTS—Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa. Catalog No. 87. Potentiometer pyrometers.

STRIP HEATERS—General Electric Company, Schenectady, N. Y. Bulletin No. GEA-1157. A few suggested uses and features of the new strip heater.

DIAMOND DRILL—Sullivan Machinery Company, 400 North Michigan Ave., Chicago, Ill. Bulletin No. 85-D. Describes "Bravo-300" diamond core drill belt-driven by gasoline engine or electric motor.

WELDING — Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Leaflet No. 20418 describing the 300-ampere gas-engine-driven arc welding set.

BLOWERS — The Connersville Blower Company, Connersville, Ind. Bulletin No. 110. Describes rotary positive blowers "R-S" and "R-B" series for the medium range of capacities and pressures (or suctions).

METERS—The Connersville Blower Company, Connersville, Ind. Bulletin No. 305. Illustrates, by views of different illustrations, the adaptability of rotary patented displacement meters to the unusual as well as ordinary requirements.

CONCRETE BREAKERS—Sullivan Machinery Company, 400 North Michigan Ave., Chicago, Ill. Bulletin No. 87-B. Describes the adaptability of the "K-2" and "K-4" busters. The "K-4" heavy duty buster is a more recent development. This tool weighs 84 lb. and is recommended for unusually heavy tasks, such as demolition of steel reinforced concrete in either pavements or in foundation removal.

Personal Notes

E. E. BARKER

E. E. Barker, formerly engineer of mines for Utah Copper, left Salt Lake City on Nov. 30 for Africa, by way of New York and London. He has been appointed general manager of the Mufulira mine of Selection Trust, Ltd. Mr. Barker has been mine superintendent for Chile Copper, Cerro de Pasco, and Butte & Superior, and engineer of mines for Nevada Consolidated.

James S. Douglas, president of United Verde Extension, has returned from Paris to Arizona.

R. J. Duncan has been placed in charge of operations for Treadwell Yukon, at Bodie, Calif.

Howard G. Wright and **John L. Mason** have joined the research staff of the Hardinge Company.

Stanly A. Easton, manager and vice-president of Bunker Hill & Sullivan, was a recent visitor to San Francisco.

William Reed, formerly with the Mexico Mines of El Oro, Ltd., is now with San Rafael y Anexas, Hgo., Mexico.

B. W. Dyer, of the U. S. Geological Survey, has returned to Salt Lake City after a trip through Oregon and California.

Frank Mercer has been appointed superintendent of the Argonaut mine, near Jackson, Calif., vice **R. Scott,** who has resigned.

G. H. Cronwoldt was elected president, and **L. W. Carrigan,** secretary, of the Northern California Mining Association at a recent meeting at Redding.

Frank M. Smith, formerly with Ventures, Ltd., is in charge of operations for Jack Nutt Mines, Ltd., at its tin properties near Bernic Lake, Man.

Dr. **R. A. Pelletier,** geologist, now with Rhodesia Minerals Concession, Ltd., has gone to the company's property to make a preliminary examination.

W. W. Lynch, formerly mill superintendent at Jerome, Ariz., for United Verde Copper, has been transferred to the New York office of the company.

Howard I. Drullard, representative of the Gardner-Denver Company in Japan, has returned to the United States and is now in San Francisco on a short vacation.

Prof. **Waldemar Lindgren,** head of the department of geology at the Massachusetts Institute of Technology, has returned to Cambridge, Mass., from Sweden.

George H. Garrey, who has just completed a geological examination of the Fairview and Cleopatra mines, near Pitkin, Gunnison County, Colo., is now in Boise, Idaho.

B. B. Gauld, of Toronto, Ont., was in New York City last week to address the Mining and Metallurgical Society of America on recent developments in electrical prospecting.

F. E. Lathe, technical assistant to the president of the National Research Council of Canada, Ottawa, Ont., was a recent visitor to Washington, D. C., and New York City.

F. M. Connell has been elected president of Amulet Mines, Ltd., operating in the Rouyn district of Quebec, to fill the vacancy created by the death of **Russell E. Popham.**

Frederick S. McNicholas, of Anyox, B. C., calls attention to the correct spelling of his name, an incorrect version of which appeared recently in *E.&M.J.,* for which apologies are tendered.

I. Partanan, formerly superintendent of the Black Bear mine, at Telluride, Colo., is now in charge of the Iowa mine, being operated in the Silverton district by the Colorado-Mexico company.

W. MacA. Johnson has sold his interests in his patents on electric smelting of complex zinc ores to **Anson T. McCook.** Mr. Johnson is engaged in research on rare mineral biochemistry.

J. M. Callow, president of General Engineering, is in New York on his way to Salt Lake City. He expects to return to London some time during January, in connection with the Mount Isa plant.

G. Temple Bridgman, president of the Mining and Metallurgical Society of America, was elected an honorary member of the Chemical, Metallurgical, and Mining Society of South Africa at a recent meeting.

R. S. McClellan, formerly with Rhodesian Congo Border Concession and Chile Exploration, has been appointed consulting engineer to Charles V. Bob & Company, and has been elected a director of the Mineral Research Corporation.

Dr. J. F. Walker, of the Geological Survey, Department of Mines, Ottawa, has been transferred to the British Columbia office at Vancouver. Dr. **F. A. Kerr** has been transferred from the British Columbia office to headquarters at Ottawa.

C. M. Eye, mining engineer of San Francisco, will leave on Jan. 3, 1930, for the Philippine Islands, where he will visit the properties of the Benguet Consolidated Mining Company. He expects to be away from the United States for six months.

Philip B. Bucky has been appointed assistant professor of mining at the Columbia University School of Mines. He comes to Columbia from the faculty of the Pennsylvania State College, where he received the degree of engineer of mines in 1926.

J. K. Bryan, Fred Benard, R. G. Knickerbocker, J. Moss, Ralph Maxwell, Earl Palmer, and **Warren Koth** have been transferred from the Chrome refinery of U. S. Metals Refining, at Carteret, N. J., to Copper Cliff, Ont., where they will be on the staff of the new Ontario Refining plant.

Thomas J. Barbour, of San Francisco, has returned from South Mountain Mines, Idaho, the property of the Exploration Company of California. Mr. Barbour and **Charles Butters** have taken over an Idaho property at South Mountain, and have organized an exploration company to develop it.

Gordon R. Campbell, president of Calumet & Arizona; **Cleveland Dodge,** vice-president of Phelps Dodge; **W. C. Bennett,** vice-president of Nichols Copper; and **E. H. Robie,** associate editor of *E.&M.J.,* expect to be in El Paso next week in connection with the beginning of operations at the new Nichols copper refinery just completed.

OBITUARY

Homer Bower died suddenly at Commerce, Okla., on Nov. 21. He had lived in the Tri-State district for more than 25 years, serving as ore buyer for American Zinc, Lead & Smelting, and later for Eagle-Picher Lead. He is survived by his widow and one daughter.

George F. Badgett died on Nov. 8, at Reno, Nev. He had lived for 74 years in various Western mining camps, and was for many years connected with the Knox interests as mine manager and scout. Mr. Badgett owned a gold claim in northern Montana, for which he had been seeking capital.

Daniel M. Barringer, well-known authority on mining geology, died at his home in Haverford, Pa., on Nov. 30. He was born in Raleigh, N. C., in 1860, and began his career as a lawyer, but after a few years he gave up the practice of law, and had been occupied as a consulting geologist since 1889. He was the author and co-author of several books on geology and mineralogy. He was a director of several mining companies, among them Shasta Dredging, Commonwealth Mining, and Hanover Bessemer Iron & Copper. Mr. Barringer is survived by his widow and eight children.

NEWS OF THE WEEK

TREATMENT of low-grade silver-lead-zinc ores from the Bawdwin mine of the Burma Corporation will be undertaken in a new 500-ton unit now under construction. Page 902.

* * *

Operation of the new lead-zinc concentrator of Electrolytic Zinc at Rosebery, Tasmania, will probably start next spring. Page 902.

* * *

Regular production of high-grade silver-lead ore from the Gloria group, in the Los Lamentos district, Chihuahua, Mexico, will start soon. Page 903.

* * *

Discussion of geophysical methods by Messrs. Lundberg, Leonardon, and Gauld was the feature of the November meeting of the M.M.S.A. Page 900.

* * *

Construction of a new cyanide plant to treat gold-bearing gossan ores has been practically completed at the Mountain Copper property, Shasta County, Calif. Page 903.

* * *

Beginnings of the gold-dredging industry in California were described by W. P. Hammon at a meeting of the gold dredge section of the California Metal and Mineral Producers' Association. Page 900.

* * *

Development has indicated a new sulphide orebody at the Fresnillo mine of Mexican Corporation, at Fresnillo, Zacatecas, Mexico. It has been proved for a length of more than 600 ft. on the 165-m. level. Page 901.

* * *

Further curtailments will be made in production of zinc concentrate from the Tri-State district because of the poor market conditions. A review of the current status of America's foremost zinc-producing area. Page 898.

The Wedge shaft and Liberty pit of Nevada Consolidated

Court Adjourns Nevada-Coppermines Case After Hearing Lasting Five Weeks

RENO, NEV., Dec. 2, 1929.—Trial of the suit of Nevada Consolidated Copper Company against the Consolidated Coppermines Corporation, in the U. S. district court at Carson City, Nev., has been adjourned by Judge Frank H. Norcross until Feb. 4, 1930, after a hearing lasting five weeks. Judge Norcross was unable to continue trial because of an assignment to sit as judge in the federal court at Los Angeles in the government's suit against the Pan-American Petroleum Company to cancel three oil leases in Kern County, Calif., which started Monday, Dec. 2.

Attorney of both litigants in the mining case estimate that probably all of February will be required to complete the evidence in rebuttal. The last witness heard was Howard D. Smith, of New York, president of Consolidated Coppermines.

Suit was brought last May for interpretation of a contract governing the mining of ore in a certain block of ground where properties of the two companies adjoin the Liberty pit of Nevada Consolidated. A stipulation was entered when the matter came up for hearing on petition of the plaintiff for an injunction restraining defendant from underground mining through its Emma Nevada shaft, to govern operations of both companies until the case was heard on its merits. Several prominent engineers and mine operators have been called to testify in the trial at Carson City.

Little Pittsburg Starts Building 250-Ton Mill

Construction of a 250-ton mill has been started at the Little Pittsburg mine, which will be operated by Pine Creek Lead-Zinc Mining, in the Coeur d'Alene district of Idaho. Concrete for mill foundations is now being poured. H. J. Rossi and M. L. Savage acquired an option on this property some time ago. By extending the No. 3 tunnel level, a continuation of the orebody developed in the No. 2 tunnel level was proven. The oreshoot averages about 7 ft. in width.

New Orebody Discovered at Sylvanite

Diamond drilling from the 800 level of the Sylvanite Gold mine, at Kirkland Lake, Ont., has indicated a new orebody, 500 to 600 ft. long and about 5 ft. wide. Assays are reported to be higher than mine average. The ore is in undeveloped ground between the Sylvanite shaft and the Tough-Oakes-Burnside boundary. Sylvanite's new west shaft will soon reach the 1,250 level, and development will be started in the upper section of the veins now under development by Wright-Hargreaves.

Tri-State Mines Forced to Curtail Production Still Further

Large Stocks and Declining Prices Necessitate Shutdowns—Increased Metallurgical Efficiency Most Notable Advance in Operations—Use of Flotation More Widespread

J. H. WADLEIGH,
Special Tri-State Correspondent

CONTINUED sharp declines in the London slab-zinc quotations, ostensibly brought about by the collapse of the American security markets in October, brought to a head an unsavory condition in the Tri-State zinc-lead district that to many was unavoidable. Mines of the district have been overproducing zinc for the last eight months, despite frequent and urgent admonishments from the retort smelters, the consumers of Tri-State concentrates, to the effect that continued overproduction sooner or later would act to the detriment of fair and profitable prices for zinc concentrates.

Stocks of zinc concentrates in the district made a steady and almost uninterrupted weekly advance from mid-April up to the present time, despite larger shipments of concentrates than were made in the first eleven months of 1928. Stocks of concentrates in mine bins at the middle of April were slightly under 20,000 tons; today they are 55,000 tons, with prospects that they will pass the 60,000-ton mark before the middle of December.

Little effort was made during April, May, and June to curb the rising stocks. A fairly successful curtailment of production was made in the Fourth of July week, during which stocks were reduced from 47,000 tons to about 40,000 tons. Output was then unrestrained until the last week in August, when frantic appeals from the smelters that growing stocks were weakening the metal markets brought about a week's curtailment that again put a temporary halt to the increasing stocks. Another curtailment of output was practiced at the end of October, and rising stocks were again halted.

October came, with its panicky stock market collapse, and with it the continued decline of London quotations, sending them below domestic parity, and forcing smelters to abandon the arbitrary price of 6.80c. a pound, which had been prevailing on slab zinc for several months.

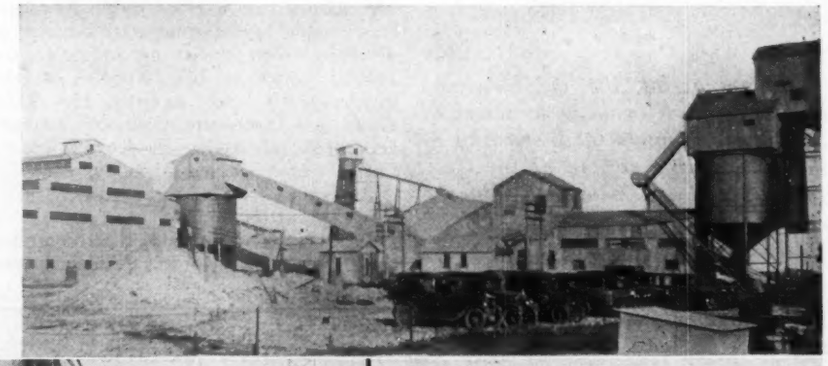
Unofficial advices from smelting centers placed the demand for Tri-State concentrates for November and December at about 60,000 tons, almost the amount of concentrates in bins, so naturally producers of the field have had but one recourse—shutting down the mines. Smelters in the last three weeks of November bought less than half the normal amount of zinc concentrate.

Practically every mining company in the field has closed down some of its mines, with the intention of cutting normal production in half. Some companies have even reduced output by 75 per cent, and most companies that have shut down mines have announced that they will be closed for several months. Naturally, conditions in a field where the productive capacity is 14,000 tons a week are seriously impaired when the demand shrinks to 6,000 tons a week. What makes the outlook darker is the fact that the smelters have a larger stock of slab zinc at plants in the United States than at any time since the post-war deflation period.

Zinc-concentrate price is $38, which means a loss to many producers. It is $6 a ton under the high point of the year. The year opened with the price at $40 a ton and it soon ran up to $44, where it was stabilized for thirty weeks. The average base price paid in the first eleven months of 1929 is $43.34 a ton for 60 per cent concentrate. Such a price would afford some profit, with lead selling at $75 a ton, the present price, provided the mines could operate at somewhere near capacity, but mills cannot run ten hours a day on part time and make much more than an operating profit.

Zinc-concentrate production in the first eleven months of 1929 was about 606,000 tons and shipments were 574,000 tons, as against production of 525,000 tons and shipment of 527,000 tons in the first eleven months of 1928. Production of lead concentrates in the first eleven months of 1929 was approximately 84,000 tons and the shipment 93,000 tons, as against production of 90,000 tons and a shipment of 89,000 tons in the same period of 1928. The combined value of the lead and zinc shipments for eleven months of 1929 is about $34,000,000, as against $28,000,000 in eleven months of 1928.

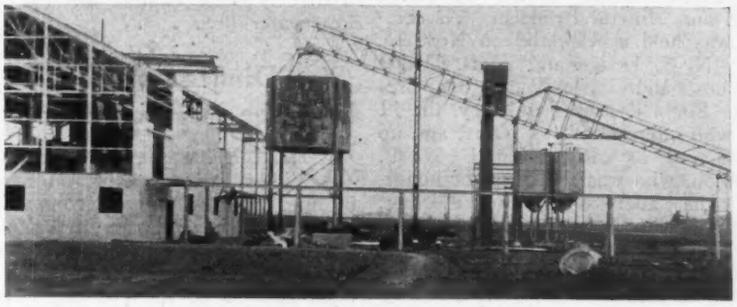
At the end of 1928 the district was producing slightly more than 2,000 tons of zinc flotation concentrates a week. At present, under normal operations, the district is capable of producing 3,500 tons of flotation concentrates a week. Smelters formerly using considerable Western zinc concentrate, and smelters formerly equipped to handle only coarse concentrates are now using, or were using, all the flotation concentrates the district could produce, with even greater demand apparent. The Tri-State flotation concentrates assay from 55 to 63 per cent metallic zinc



Three modern Tri-State plants. Below, left, the Paxson mill of Commerce Mining & Royalty, near Baxter Springs. Below, right, ore-picking plant of the Hartley mine, Interstate Zinc & Lead. Right, St. Louis Mining & Smelting concentrator.

and average about 58 per cent, with impurities amounting to only about 1.35 per cent iron and from 1 to 2 per cent lead. At the beginning of the year considerable flotation zinc was in the surplus stock, but today the flotation stock is nil. The increase in stock has been solely of coarse grades of concentrate.

Distinct advances have been made in the metallurgy of the district during the past year. The grade of flotation concentrates has been increased from a metallic content of about 56 per cent to the present average of 58 per cent. Impurities of lead and iron have also been reduced. In fact, the mines of the district can make their flotation concentrates average close to 60 per cent were such a procedure desired.



Framework of Commerce Mining & Royalty's new Bird Dog concentrator, of all steel-construction.

The increased demand for these concentrates has focused the efforts of the metallurgists of the district on improving recovery in these fine grades of concentrates. Few are the tailing piles of the present day that will assay more than 1 per cent zinc and lead. Recovery of metallic contents in the last four or five years has increased from an average of 65 per cent to almost 90 per cent, with some of the newer plants doing better.

More than twenty tailing mills have been operating throughout the year, producing around 1,200 tons of concentrates a week. These mills are operating on tailings produced in former years. Some are treating material assaying 4 per cent combined metals, which discloses the enormous losses incurred in the past.

Mining companies have been bending every effort to lower costs, with considerable success. Average cost of producing a ton of concentrates in 1929 has been about $39 a ton, which includes depreciation and depletion, as against a cost as high as $48 a ton a few years ago.

Operators have been leaning toward a different method of mill construction and a different method of mining. Practically all the mills erected last year have been of steel construction throughout, in place of the conventional wooden frame with galvanized-sheet coverings. The mills are larger, the present popular size being 100-ton capacity per hour, as compared with the 30- and 40-ton capacities of previous years. Larger acreages have been essential to these promotions. In the past forty acres usually constituted the average lease in the field, whereas the new mills are being constructed on leases of several hundred acres, making steel construction possible. These leases, however, do not certain the same rich ores as characterized a majority of the deposits of the old Picher district.

Commerce Mining & Royalty and St. Louis Mining & Smelting have built immense steel mills in the west Baxter Springs section, which is of a semi-sheet ground formation. Interstate Zinc & Lead, at its Hartley mine, west of Baxter Springs, initiated a new milling practice in the field at the beginning of the year, which C. F. Dike, manager of the company, says has cut costs. This company built an underground ore bin and crushing plant at the main headframe. The ore is crushed and then transported by belt conveyor to a shaker screen in a sorting house. All ore over 4 in. goes to three picking belts, where the ore is picked from the waste and sent to the mill ore bin with the ore under 4 in., where it is crushed for concentration.

Commerce is building an all-steel plant on its Bird Dog lease, west of Commerce, Okla., to handle the ores from ten or twelve restricted Indian allotments. Arrangements have been made for the automatic weighing of ores from the various allotments. Cut samples will be taken from each allotment and sent to one of four 50-ton ore bins directly underneath the belt conveyor running from the surface ore bin and crushing plant to the mill ore bin. By this method the company will allocate to each allotment the amount of ore, less tailing losses, to which it is entitled.

In keeping with the demand for flotation concentrates, John L. Mining recently completed a mill in the eastern Oklahoma section that was constructed so that it can be entirely converted to flotation by the addition of extra machines.

The Tri-State Zinc and Lead Ore Producers' Association, under the leadership of Frank Childress, remains the bulwark of the district in legislative measures that are constantly being introduced in the state legislatures of Missouri, Kansas and Oklahoma, which would increase the cost of mining. M. D. Harbaugh succeeded Julian D. Conover as secretary of the organization when Mr. Conover was elected secretary of the American Zinc Institute.

The accident-prevention department of the association, under the leadership of Fred Nesbitt, continues to prove its worth to the employee and the employer. Accidents in the field have been reduced remarkably in the last few years. At present sixteen companies are employing safety engineers, who meet once a week with the association's safety director. From these meetings many accident prevention policies have been derived.

The R. C. Allen Zinc Sales Agency has not yet been in existence a year, and it is too early to determine what effect it will have on the economics of the industry. So far it has been able to bind only about 65 per cent of the production of the field, and this has been a drawback to its success. The agency made an attempt early in October to increase the price of flotation concentrates, but the price debacle put an end to this.

About half the district's labor is unemployed, with prospects that it will be unemployed for several months.

Great work has been done by the Tri-State clinic, at Picher. This organization is supported by the U. S. Bureau of Mines, the Metropolitan Life Insurance Company, and the producers. Every man in the district has been given a thorough physical examination at no cost. The number of silicotics has been materially reduced and many physically unfit men have been warned of the danger of continued employment in mines. The work of the clinic is directed by Dr. F. V. Meriweather, who deserves considerable credit for the success of the institution.

Welfare work of the district, which for the coming winter will be necessarily increased, is now being done by the producers' association, under the guidance of Richard Jenkins, since the Tri-State section of the American Zinc Institute was disbanded earlier in the year. The department employs two full-time nurses.

The district has faced many a situation such as now prevails and has always come out in better condition than ever. Leaders of the industry are confident that a few months will see the Tri-State field enjoying prosperity.

Castle Peak Declares First Dividend

Although production was started only on Sept. 3 of this year, Castle Peak Quicksilver, operating a mine 20 miles east of Reno, Nev., has declared its first dividend, amounting to $1 per share on 20,000 shares. The property was taken over by the company in February, 1928. A 40-ton Gould rotary furnace was installed at a cost of about $40,000 and an electric power line erected. To obtain water, 3½ miles of pipe was laid. All equipment and installations have been fully paid for and the mine is estimated to have developed 100,000 tons of ore, averaging 0.75 per cent quicksilver.

Geophysics Increasingly Used in Structural Work

RECENT developments in electrical methods of prospecting were discussed by speakers prominent in geophysical exploration work at the monthly meeting of the Mining and Metallurgical Society of America at the Harvard Club, New York, on Nov. 26. H. DeWitt Smith presided.

Hans Lundberg, of the Swedish-American Prospecting Corporation, compared results obtained by diamond drilling with those gained by electrical prospecting work at the Buchans mine, in Newfoundland. Over 100 holes had been put down, the results amply justifying the work performed. From this the speaker passed to the topic of mapping subsurface structure by electrical methods, much used in locating oil pools and salt domes and having possibilities in the search for ore. He described how, with a closed loop and an alternating current, it was possible to determine the depth to some particular bed, and also the electrical characteristics of the bed itself; and how in general, by such means, strata could be correlated and structural problems worked out. With a crew of twelve to fourteen men, he said, about twenty square miles of ground could be surveyed per month and to a depth of about 500 ft.

Following Mr. Lundberg, E. G. Leonardon, manager for Schlumberger Electrical Prospecting Methods, took up the subject of applying electrical resistivity measurements to correlating geological formations traversed by drill holes. As the chairman later remarked, the geophysicist, finding himself unable at the surface to tell much about what was to be found at depth, went down a drill hole.

In the first part of his talk, Mr. Leonardon concerned himself with the possibility of making certain structural studies by sending into the interior of the soil an electric current when an open drill hole was available for the purpose. In such cases, of course, the electrical measurements were made at the surface. He then referred to the use of the drill hole for taking the measurements themselves in the interior of the soil. In this case it was possible to measure the specific electrical resistance of the rocks traversed by the drill hole and to use these quantities for correlating between several holes. Such work, he said, had already had considerable commercial success in Europe and the United States.

The third and last speaker, B. B. Gauld, of Mason, Schlichter & Gauld, talked on the advantages of using quantitative measurements as much as possible. Most of the work done hitherto had been qualitative. In most cases in the United States and Canada no attempt had been made to examine on a quantitative basis. When absolute magnetic measurements rather than relative ones were utilized, Mr. Gauld pointed out, it was often possible to get relatively accurate ideas as to location, extent, and magnetic grade of the conducting body. The last depended on the particular constituents involved as well as on their percentages. The response obtained from any magnetic mineralization would have a certain limit depending upon the susceptibility of the material. Moreover, some of the magnetic minerals were far better conductors than others, which helped to differentiate between them. Some were more likely to occur in consistent fashion than others, so that, if results were erratic, this would indicate the probability that the response was due to magnetite or some other mineral that segregates in similar fashion. Sometimes, the speaker said, it was important to know the relative amounts of minerals, since this would give an idea as to the consistency of mineralization; also as to its economic character where the various minerals occurred in a more or less fixed ratio.

Hammon Addresses Gold-Dredge Operators

THE "get-together" of the Gold Dredge section of the California Metal and Mineral Producers' Association was held at Oakland on Nov. 15, 1929. N. S. Dodge and G. B. Dodge were hosts and Charles W. Gardner presided. For a declining industry, the 71 men who attended are as robust and up and coming as can be found. W. P. Hammon, who was the guest of honor, gave the address of the evening, reminiscing on the beginnings of the industry in California.

In starting out, Mr. Hammon said that he had no idea of what gold dredging would develop into. It had as humble a beginning as could be imagined. Everybody knew that the early miners of Oroville recovered considerable gold from the placers. Subsequent to the first working, 10,000 Chinese worked with pick and shovel and made a good living, preferring to work for themselves rather than for wages.

In the beginning Mr. Hammon did not have much encouragement in attempting to exploit the placer deposits. He dug shafts where the Chinese had worked previously, but he lost $35,000 at the outset. The problem was to find a way to get the gold out. At that time the Bucyrus company had built a dredge for excavating part of the Chicago drainage canal. It was the last word in dredges. Mr. Hammon entered into correspondence with the company, then in the hands of a receiver.

About this time he also met R. H. Postlethwaite, who had lately arrived from New Zealand and who was familiar with gold dredging in that country. Thomas Couch, of Butte, also became interested. The three men decided to order a dredge. It was put in operation on March 8, 1898, and paid from the start.

The first hydro-electric power plant in the Oroville district was constructed about this time. The dredge was the second customer. Wood had been burned under steam boilers before the advent of electric power. The first dredge required fifteen cords of wood daily. With 34 dredges operating in the Oroville district, each equipped with a 50- to 125-hp. boiler, and averaging 30 cords daily, 1,000 cords would have been required for steam power. Electric power made the dredging business possible.

At first they dredged to 30 ft. in depth, then 40 ft. On the Yuba River they were confronted with the problem of dredging to 60 ft. The slack in the bucket line made this impossible at first, but H. G. Peake, a draughtsman of the Bucyrus company, evolved the principle of the bucket idler. Today a dredge is being built to dig 100 ft. below water line.

Give Dinner for Bain in Globe-Miami District

A DINNER was given at the Cobre Valley Country Club, on Nov. 25, by the principal mining companies of the Globe-Miami district of Arizona, in honor of H. Foster Bain, secretary of the A.I.M.E. Mr. Bain made the principal address of the evening. He described the services and benefits of the Institute to the mining industry, and also dealt with his trip to Colombia as advisor to the government of that country.

Russell Fleming, field representative of *Mining and Metallurgy*, discussed plans for organizing a local section of the Institute. About 100 mining men of the district were in attendance. Harry Barkdoll and Harry Leidich, of Old Dominion, were so late they almost had to forego the turkey, but they had a good alibi. A fire started in the Old Dominion blacksmith shop as they were about to leave, and they had to see that it was extinguished. As the blacksmith shop is near the main shaft, the fire might have had serious consequences.

Mill Near Telluride Burns

On Nov. 24, the mill at the Alta mine, 9 miles from Telluride, Colo., was completely destroyed by fire. The plant, which had not been operated for some time, was owned by John and George Wagner. Sale of the properties is said to be pending.

Develop Moffat Estate Area

Development of 500 acres of mining ground, which it acquired from the Moffat estate, is being undertaken by East Leadville Development at Leadville, Colo. The property, formerly operated by the late David H. Moffat, comprises the Resurrection and Gold Contact groups. Under the direction of John Harvey, crosscuts are being driven from three shafts at a depth of 1,000 ft. One of these, 300 ft. long, will connect with the Yak tunnel, operated by American Smelting & Refining. The ore, which carries lead, zinc, silver, and gold, will be handled through the Yak tunnel.

New Orebody Discovered at Fresnillo

DEVELOPMENT work on the 165-m. level of the Fresnillo mine, Mexican Corporation, at Fresnillo, Zacatecas, Mexico, struck a new sulphide vein some time ago. Since then, a narrow orebody of good grade has been proved for a length of 624 ft. on this level. It is known as the Plomosa orebody and averages 8.7 per cent lead, 12.2 per cent zinc, 10 oz. of silver, and 0.6 dwt. of gold to the ton. On the 105-m. level, the orebody has been drifted on for 46 ft. The management believes that the top of the shoot is near this level. Work is now progressing on the orebody on the 215-m. level. Drifts have shown 31 ft. of ore to date.

A diamond drill from the Plateros workings, west of this vein, cut it at a depth of about 173 m. at a point 800 ft. west of the west drift on the 165-m. level. At this point the width is greater than in the part proved by lateral work, and also shows 3.2 per cent copper. The vein appears to have important possibilities to the west and at depth.

The main shaft is now being stripped to full section between 340 and 425 m. Development of the main and east oreshoots of the Cueva Santa vein at this depth has been favorable. The east oreshoot has already been proved for a greater length at this depth than in any of the levels above. Preparations are being made for sinking the Saraos shaft, and two interior auxiliary shafts, at the east and west ends of the Cueva Santa vein, to 550 m.

Production from the property continues at capacity, with 70,000 tons of oxide ore and 20,000 tons of sulphide ore treated monthly.

Bunker Hill to Complete Changes by March

Enlarging of the refinery capacity at the Bunker Hill & Sullivan lead plant, in the Coeur d'Alene district of Idaho, has been kept up to schedule and the remodeled plant will be ready in March, when the contract with American Smelting & Refining expires. Total cost of the changes, which are also expected to improve the efficiency of the plant, is estimated at about $500,000. Formerly half of Bunker Hill's output was treated by American Smelting & Refining. Although the smelter capacity is large enough to permit treating the entire output of the mine, refinery capacity had to be doubled.

Base Metal Puts Mill on Three-Shift Basis

Operations of the Base Metals concentrator, near Field, B. C., were put on a three-shift basis on Monday, Dec. 2, according to George Wingfield, president of Goldfield Consolidated, which controls Base Metals. The plant has a nominal rated capacity of 300 tons of lead-zinc ore daily, but results obtained in milling since it was started on Nov. 16 indicate that the actual capacity will probably prove to be 350 tons. Hardly any readjustments have been required, Mr. Wingfield reports, and the mill is running unusually smoothly.

Activity in Lode and Placer Mines Near Fairbanks

After an inactivity of several years, interest is being revived in Ester Creek, near Fairbanks, Alaska. Five parties are prospecting for placer ground along the creek. Two parties are reported to have proved large areas of gravel.

Quartz mines in the same area are also active. A good strike was made last spring at the Mohawk mine, the largest producing quartz mine in the Fairbanks district. Drifting has proceeded for 200 ft. along the orebody, with average widths of 4 ft. of high-grade ore.

Sub Nigel to Increase Mill Capacity Slightly

MILL capacity at Sub Nigel, in the Witwatersrand district, Transvaal, will be increased to 27,000 tons a month, as compared with about 24,500 tons at present, according to D. Cristopherson, resident director in Johannesburg of Consolidated Gold Fields of South Africa. This increase has been justified by the acquisition of 153 claims from the government on favorable lease terms.

The claims had been abandoned several years ago as having been exhausted, but under modern methods a considerable tonnage of ore is believed to be available. None of this has been included in the official estimate of 891,000 tons of 18.2 dwt. ore, on June 30, 1929. Since then development has disclosed high-grade ore in the 28-3 east drift for 160 ft. and in the 28-5 haulage level for 250 ft. A large upthrow fault in the 28-3 east drift has prevented further work on the ore at this depth. Its extensions are being opened by raises and winzes, however.

Teziutlan to Sink Shaft to Develop New Orebody

Sinking of a new shaft at the Teziutlan unit of the Mexican Corporation, at Aire Libre, Puebla, Mexico, will be started to develop the new copper orebody indicated by diamond drilling. The shaft will be put down to 400 m., as the drilling indicated that the ore is about 50 to 60 m. beneath the 300-m. level. The new shaft is expected to take from a year to eighteen months to sink. In the meanwhile development above the 300-m. level has continued to be satisfactory. Operations are still at about 200 tons daily, with profits about $200,000 a year.

Continental Kirkland Closes

Operations have been indefinitely suspended at the Continental Kirkland property, in the Kirkland Lake district of northern Ontario, according to R. A. Bryce, president of the company. Two large veins were developed on the property, but no ore was found of sufficient importance to justify additional expenditure. Sufficient money is in the treasury to pay taxes and other incidental expenses.

Delay Shenandoah Mill Start

Starting of the new 300-ton concentrator of Shenandoah-Dives, in the Silverton district, Colorado, has been delayed by difficulties encountered in constructing the 10,000-ft. tramway that will connect the mine with the mill. The plant will probably be put into operation late in December. It will handle a complex silver-lead-copper-gold ore, and is expected to produce 60 cars of concentrate monthly. Construction of a five-story dormitory for the miners has been completed, and a new 2,000-cu.ft. Chicago Pneumatic air compressor has been installed in the mine. The total cost of equipping the Shenandoah-Dives property for production is estimated at $600,000. The concentrator has been built to permit doubling capacity when mine development warrants.

Yuba Con. Dredges Exhausting Available Area

Dredging operations of Yuba Consolidated Gold Fields, at Hammonton, Calif., are being conducted on a smaller scale as the available dredging area of the company is approaching exhaustion, according to F. C. Baker. Only four dredges are operating at present, as dredges Nos. 16 and 17, which furnished about 55 per cent of the total output formerly, were closed last year. Of the four dredges in operation, two are expected to suspend within a short time.

Gold Hill May Build Mill

Preparations are being made for construction of a 200-ton cyanide plant, in two 100-ton units, at the Gold Hill mine, near Round Mountain, Nev. Tests indicate that the ore is amenable to cyanidation. Sampling of the orebody has been completed on the 225 and 400 levels. On the first of these levels it has been proved for a length of 662 ft. and on the second for 515 ft.

Altamont Starts Mill

Operation of the Pride of the West mill, in Cunningham gulch, near Silverton, Colo., was started by Altamont Exploration on Nov. 29. The plant has a capacity of about 100 tons, but had been closed down since last spring. Output is expected to be about 480 tons of concentrate a month. Ore is silver-lead.

Burma Corporation Preparing to Treat Low-Grade Ore

AN ADDITION of about 500 tons daily is being made to the capacity of the Burma Corporation concentrator at the Bawdwin mine, in Burma, India. This additional unit will treat a large tonnage of low-grade ore already developed and available in the Chinaman and Shan orebodies, but not included in the ore reserves to date. Part of this plant is expected to start operations by June, 1930. An experimental mill has been erected to determine a flow sheet for a plant for treatment of copper ore carrying lead and zinc. Selective flotation will be used and three kinds of concentrate produced.

Ore reserves in the mine, on July 1, 1929, were estimated at 4,140,969 tons, averaging 25.9 per cent lead, 15.8 per cent zinc, 1.05 per cent copper, and 21.2 oz. of silver to the ton. This shows an increase of 48,218 tons over the tonnage estimated for the previous year, despite the extraction of 463,057 tons during the year. Development work on the Shan lode added about 225,000 tons of 33 per cent lead ore, carrying only 10 per cent zinc. More tonnage of high-grade ore has been developed on the No. 9 level than on the levels above, according to E. Hogan Taylor, general manager of the company.

Rosebery Plant Expected to Start Producing in April

PRODUCTION of concentrate from the new 500-ton plant being built at Rosebery, Tasmania, Australia, by Electrolytic Zinc will probably be started in April, according to H. St. J. Somerset, manager of the company. Permanent railroad connection from the mill to the Emu Bay railroad has been made. Concentrate will be shipped over the railroad to Burnie, whence it will be transported by steamer to the Risdon electrolytic zinc plant.

During the year ended June 30, 1929, a total of 39,152 tons was mined from the Rosebery and Hercules mines and treated in the pilot plant at Zeehan. The average grade of the ore was 21.7 per cent zinc, 5.9 per cent lead, 7.4 oz. of silver, and 1.8 dwt. of gold to the ton. Zinc concentrate production was 15,545 tons, containing 50 per cent zinc, 5 per cent lead, 8.7 oz. of silver, and 1.2 dwt. of gold to the ton. Lead concentrate output was 2,705 tons, containing 48.6 per cent lead, 17.4 per cent zinc, 44.5 oz. of silver, and 8.2 dwt. of gold to the ton. Most of the ore treated came from development.

No new work was undertaken in the Rosebery mine, operations underground being confined to blocking out the known orebody. At the Hercules mine, exploration of the new orebody on the upper levels was undertaken. A length of 230 ft. was proven on the 3a level. No work has been done on this orebody below the 4 level, but Mr. Somerset believes that prospects of developing large tonnages at depths are good. Driving on the South Hercules orebody has indicated a length of 170 ft., averaging 10 ft. in width, carrying 26 per cent zinc, 7 per cent lead, 6 oz. of silver, and 2 dwt. of gold to the ton. From the end of the drift, a crosscut was driven to the Mount Read orebody, which was 40 ft. wide at this point, and of high grade. Footwall drifts north and south on this orebody have already indicated a length of 160 ft. The South Hercules orebodies have been opened on only one level, and no tonnage estimates have therefore been made. A drive has been started from the Hercules mine on the 5 level to connect with the South Hercules workings.

Ore at Depth Maintains North Broken Hill Reserves

DEVELOPMENT of the North Broken Hill orebody on the 1,550 and 1,700 levels has maintained the company's ore reserves at about 4,000,000 tons of silver-lead-zinc ore in both the North and the British mines, Broken Hill district, New South Wales, according to C. J. Emery, general manager of the company. On the 1,550 level of the North Broken Hill mine the orebody has been proved for 1,383 ft. A crosscut 1,021 ft. north of the main crosscut showed a width of 24 ft. of ore, which compares favorably with the same orebody on the 1,400 level. On the 1,700 level the orebody has been proved for 483 ft., with further development in progress.

Sinking of the new shaft, which will handle ore from the 1,700 level and below, is progressing. Crosscuts are being driven to the location of the shaft on the 800, 1,250, and 1,700 levels. Raises will be driven from these crosscuts to expedite shaft sinking.

At the British mine a winze will be sunk from the No. 13 level to determine the continuity of the northeastern orebody at depth. Not much prospect exists of further discovery by lateral development in this section.

At the company's concentrator, additions have been made which have increased the capacity to 1,300 tons of crude ore daily. Research is being conducted with the hope of improving the zinc recovery at the plant. For the year ended June 30, 1929, recoveries were 93 per cent of the lead, 83 per cent of the silver, and 77 per cent of the zinc content. This compares with recoveries of 90, 79, and 79 per cent, respectively, in the preceding year.

Mines Give Flagpole

Dedication of a new flagpole, a gift of several Utah mining companies to the University of Utah, was held on Nov. 27. Utah Copper donated the base; Columbia Steel, the 50-ft. steel pole; and American Smelting & Refining presented the large flag. Speeches were made by G. H. Dern, Governor of Utah; W. H. O'Connor, of A. S. & R.; Dr. George Thomas, president of the university, and Dr. G. F. Merrill.

Immense Gravel Plant Designed for Russia

THE largest gravel plant outside the United States will start next spring in Russia to furnish material for the construction of an 80,000 kw. hydro-electric plant near Leningrad. Eight carloads of machinery, consigned to the Russian Soviet, have been shipped by the Smith Engineering Works, of Milwaukee, Wis. The order was placed through the Amtorg Trading Company, the official purchasing agents for the Russian Soviet.

The plant consists of two complete and identical units, each having a washing and screening capacity of 300 cu.yd. per hour. Telsmith Hercules washing screens are a feature of the installations, the main cylinders of which are 72 in. diameter by 24 ft. long. The sand jackets are 99⅜ in. diameter by 14 ft. long. Each screen weighs 30,000 lb. and has a capacity of 300 yd. yer hour. Both screens are equipped with Timken roller bearings.

Report Strike at Belmont

An oreshoot, assaying 9 per cent copper, has been proved for a distance of 125 ft. on the 1,400 level of the Belmont mine, at Superior, Ariz., according to reports from the mine. The ledge was intersected in a crosscut driven toward the old Grand Pacific ground. The company had planned to sink a new shaft in this area, and the reported strike is expected to speed up this development.

Mt. Morgan Tests Leaching

Testing of a new leaching process for treatment of Mount Morgan ore is now being undertaken by the new company, Mount Morgan, Ltd., which has acquired the property in northern Queensland, Australia. Preliminary tests indicated that the material lying above the Linda, or 450, level could be treated profitably by this method. Tests will also be made on the large tonnage of junore below the Linda level, which is being developed under the direction of A. A. Boyd, who has returned to Australia from the United States.

To Build Adams River Plant

Construction of the Adams River 30,000-hp. hydro-electric plant by West Kootenay Power & Light, a subsidiary of Consolidated Mining & Smelting, will be started early next spring, according to L. A. Campbell, general manager of the company. It will supply power for the Trail reduction works of Consolidated Mining & Smelting and will cost $2,500,000. Permission has been obtained by the company to build a dam across the exit of Kootenay Lake to raise the low-water level of the lake 6 ft. The dam will cost $1,250,000 and will materially increase the average capacity of the company's three hydro-electric stations on the Kootenay River.

Surface plant and ore and waste dumps at the Tajito mine, Copala, Sinaloa

United Eastern Building Mill at Copala

CONSTRUCTION of a flotation plant at the United Eastern property at Copala, Sinaloa, Mexico, has been started. The first unit will have a capacity of 75 tons daily. Jaw crushers, a Marcy ball mill, and a modified Krupp mill will be used for crushing and fine grinding. Selection of flotation machinery has not yet been made, but is awaiting the outcome of tests which the company will conduct, according to R. W. Moore, general manager.

At Copala, the ore carries silver sulphides. In the Tajito vein, the content assays from $18 to $20 a ton. About $2 to $5 in gold is associated with the silver. Several other veins on the property have been productive, but none have been worked below 168 ft. Development will be undertaken as soon as a new power plant is installed. The company will place orders for two Diesel-electric units of not less than 480 hp., combined capacity.

Mountain Copper Completes Cyanide Plant

CONSTRUCTION of a new cyanide plant, designed to treat gossan ores containing gold, has been practically completed by Mountain Copper, operating mines in Shasta County, Calif. The construction crew has been disbanded and the plant will soon be started. About 350 tons of copper ore is being mined daily from the No. 8 mine and treated in the flotation plant. Copper concentrate, amounting to about 30 tons daily, is shipped to the Tacoma smelter.

Production of pyrite from the Hornet mine has been suspended, as competitive pyrite is being sent to the San Francisco market from British Columbia. The Hornet mine has been producing 200 to 300 tons daily for the last twenty years. The railroad company is expected to lower freight rates from Shasta County to permit resuming production. About 325 men are now employed at the property.

Ship First Ore From Two Portland Canal Mines

The first shipment of ore from the Prosperity and Porter Idaho properties, on the north fork of the Marmot River, Portland Canal district, British Columbia, has been made by Premier Gold, which controls the properties. The shipment amounted to about 600 tons. Construction of the cable tramway connecting the mines to tidewater has been completed. It is 5½ miles long, some of the towers are 80 ft. high, and at one point the cables are more than 1,000 ft. above the canyon below. The span across the north fork glacier is 4,200 ft. long.

To Start Regular Production From Gloria Mine

REGULAR mining operations will be started within a short time at the Gloria group, composed of several claims, some of which are owned outright and others held under lease by California-Ahumada Mining through a Mexican subsidiary, in the Cerros Colorados, Los Lamentos district, Chihuahua, Mexico. The mines are about 8 miles by road from the Chihuahua & Oriente Railway. An output of 1,000 to 1,200 tons a month of silver-lead ore will be maintained.

The property has been under development by Pardners Mines Corporation, of New York, of which H. E. Talbott, Jr., is president and J. G. Baragwanath, vice-president. Underground work consists of a vertical shaft with levels at depths of 19, 50, and 80 m. Considerable drifting, crosscutting, and raising has been done, particularly at 50 m. Four orebodies have been discovered to date, containing about 30,000 tons of ore. Ore from development, amounting to 1,550 tons, has been shipped to the El Paso smelter of American Smelting & Refining. The average of these shipments is about 43 oz. of silver to the ton and 23 per cent lead, which probably closely represents the grade of the ore now in sight.

The only deposits of ore developed to date are on the Gloria claim. They occur in the Cretaceous limestone which has been so productive throughout northern Mexico. At the surface, and extending to a depth of about 200 ft., is the so-called Los Lamentos limestone, the bed in which the main manto of the Erupcion and Ahumada properties, in the same district, lies. Below this is a great thickness of blue limestone, considered relatively unfavorable for ore formation.

The orebodies, lenticular in form, are found along a fissure bearing northeast, with which an irregular felsitic dike is associated. Mineralization was apparently in three stages: a barren pyritic stage, a silver-bearing copper stage, and a silver-bearing lead stage. All ores are oxidized, and the copper-silver ore has enriched the barren iron and lead-silver deposits. Two types of ore were found—a lead-carbonate ore, assaying about 20 oz. of silver to the ton and 40 per cent lead, and a ferruginous ore, assaying 40 to 100 oz. of silver to the ton, 0.5 to 2 per cent copper, and 5 to 15 per cent lead. Although no ore has yet been discovered in the underlying blue limestone, chances of further discoveries in the overlying fossiliferous lime are considered good.

Harcourt Wins Appeal in Jackson-Manion Case

An appeal from the sentence of H. E. Harcourt, formerly managing director of Jackson-Manion Mines, has been upheld by the Appellate Court of Ontario, and the charge against Harcourt dismissed. This case, which has been the chief action taken to date under the Security Frauds Prevention Act, charged Harcourt with unlawfully making, circulating, publishing, or concurring in false statements relative to Jackson-Manion Mines, a gold property in the Patricia district. On this charge he was found guilty and sentenced to fifteen months' imprisonment.

Report Strike at Genii

Genii Mining is believed to have cut the Mammoth Channel in an incline winze from its 3,000-ft. tunnel near Magalia, Calif. The tunnel had failed to find the channel. Gravel averaging about $10 per cubic yard is reported in the incline, which has reached a vertical depth of 50 ft. Development has been started.

Swedish Mine Production Lower in 1928

THE value of products derived from mining and smelting operations in Sweden in 1928 showed a drop of 7.2 per cent contrasted with the figures for the preceding year, according to the Swedish Department of Commerce. The decline was brought about chiefly by labor difficulties.

Mines, quarries, and smelters in operation in 1928 totaled 778, employing 60,367 men. Power consumption for the year by this group amounted to 520,411 hp. The total value of the output was 336,942,035 krona, or $90,300,500. Of the total for the year, the iron and steel industry accounted for kr. 264,201,042; non-ferrous metals and products, kr. 15,768,935; coal, kr. 4,721,466, and quarry products, kr. 52,250,592.

BY THE WAY

A Tactful Confession of Error from Spokane

LITERATURE is replete with example of young ladies who, for reasons politic or amatory, have chosen to disguise themselves as members of the sterner sex. Until last week's Spokane News Bureau release appeared, however, no one had ever heard of a mine that indulged in this peculiar sport, at least no one in the environs of *E.&M.J.* But experience never seems to tire of pointing out the danger of jumping to a conclusion. As proof, the following is offered:

"The Copper King Mining Company has been renamed the Copper Queen Mining Company, according to Daniel Louverty, who returned to Spokane from the property in the Lolo mining district, Idaho County."

One wonders if Daniel blushed as he made this delicate announcement and also if it was exploratory work that disclosed the original mistake in naming the property, or if the advertising value of the words "Copper Queen" provided the major reason for the change. In any case, this exhibition of chivalry, tact, and gallantry should not go unsung. Let the prospector investigate before he honors his prospect with a name.

Will Diamond Drill for Pier Sites Under Water

A CONTRACT for test borings of pier sites for a suspension bridge across the Golden Gate, San Francisco bay, has been awarded to the E. J. Longyear Exploration Company, of Minneapolis, Minn. There will be two pier locations in water, and about six drill holes will be put down at each pier site, in from 50 to 60 ft. of water. For this operation, the diamond drill will be mounted on a platform on top of a steel tower. Four heavy mooring cables with three-ton anchors will hold the tower in place. Work will be done by the drilling contractors at once.

The Tin Industry in Scotland

INCREASING quantities of tin flowing from County Lanark, Scotland, to London dealers gave credence a short time ago to the rumor that a large tin deposit had been discovered on the banks of the Clyde. Recently, however, the city of Glasgow issued a report revealing that the tin comes from the city's dumps where waste tin cans are thrown. Intrigued by the report, the London *Times* investigated the subject and found that the business of recovering the waste metals of cities was still in its infancy in England. Concerning the amount of scrap metals available per unit of population, the newspaper says:

"It is estimated that in an average town there are five tons of metal scrap yearly for every 1,000 of the population. Of this 60 per cent is tin cans and 40 per cent is various forms of iron. In a city of a million inhabitants, therefore, there should be 50,000 tons of scrap metal a year, with perhaps 30,000 tons suitable for detinning and likely to realize up to 35s. a ton. In a town of 50,000 inhabitants the tin scrap may amount to 150 tons a year. Every ton of tins treated represents a week's work for a British workman."

Automobile Industry Large Consumer of Metals

THE importance of the automobile industry as a factor in the growing demand for metals was illustrated by figures showing the amounts of steel, copper, lead, tin, zinc, nickel, and aluminum used in the manufacture of motor vehicles in 1928, compiled by the U. S. Department of Commerce.

Steel consumed in motor cars and trucks in 1928 totaled 6,700,000 tons, or 18 per cent of domestic production. Copper used in the industry aggregated 135,000 tons, or 14.6 per cent of production. Lead absorbed, principally in storage batteries, amounted to 160,000 tons, or 25.6 per cent of production from domestic ores. Of tin deliveries in 1928, 19,000 tons, or 24.1 per cent, was absorbed by the automobile industry. Of 90,000 tons of aluminum produced in 1928, 25,000 tons, or 27.7 per cent, entered into the automobile and truck output. Approximately 27,000 tons of zinc, or 4.5 per cent of the production, and 14,000,000 pounds of nickel, or 28 per cent of the domestic consumption, were used in the industry.

Wages Must Go Up; Prices Must Come Down—Ford

IN THIS country the purchasing power of the people has been practically used up, and still they have not been able to buy all that they must have. I therefore suggest the need of increasing the purchasing power of our principal customers—the American people.

"This may be done in two ways—first by putting additional value into goods or reducing prices to the level of actual value, and, second, starting a movement to increase the general wage level. Nearly everything in this country is too high priced. The only thing that should be high priced in this country is the man who works. Wages must not come down; they must not even stay on their present level; they must go up. And even that is not sufficient of itself—we must see to it that the increased wages are not taken away from our people by increased prices that do not represent increased value. The country gains no benefit by letting the working man earn an extra $100 and then taking it away from him again in increased rents and a rise in prices generally. To make wages better and to keep prices down requires that business men come back into business—as many are doing since the stocks came down."—*Henry Ford.*

Stock Crash Seen as Aid to Mine Development

MINING engineers watching economic developments at Washington are agreed that, in common with other productive enterprise, mining will be assured of additional funds for financing improvements as the result of the stock-market debacle. Prospecting will be particularly active during the ensuing year, it is believed.

One mining official, after making a study of similar situations that have occurred on the stock market during past years, has reached the conclusion that in each case the mining industry piled up new production peaks. Whether or not the loss of paper profits will tend to slow down the nation's business progress, the mining industry as a whole is said to face the future in the best condition that it has enjoyed for years.

Principally copper, but other mining industries to a lesser degree, have materially improved their condition during recent years. Fixed charges have been substantially reduced and a large amount of refinancing has been accomplished. Several factors are said to indicate a good market for metals. These include the large railroad electrification projects that are planned, expansion in public utilities, and increased building construction.

Raw Materials in War Time, and the Politician

PRESERVATION of peace through an international league of industrial leaders controlling the world's basic raw materials, as proposed by Edwin N. Hurley, prominent $1 a year man of wartime, to M. Georges Theunis, president of the International Chamber of Commerce, is scouted as impractical by politico economists in Washington. The proposal contradicts this government's policy of non-participation in industrial alliances, cartels and the like as well as political compacts. Though admitting that no nation has a sufficient supply of all essential raw materials to wage war independently of a foreign base of supply, government officials do not see how an international agreement among the individuals controlling these resources to withhold them from warring nations could be effective.

If the Kellogg anti-war pact means anything it denounces everything but defensive warfare, they declare.

MARKET AND FINANCIAL NEWS

World Zinc Production Shows Little Change

ZINC statistics for October showed world production of 135,697 tons, against 133,115 tons in the preceding month. The daily rate of production was slightly below the September level. The American Bureau of Metal Statistics reports that October was the first month in which zinc produced in this country from Mexican ore was listed as Mexican production. This explains the drop in United States production for the month and the gain in Mexican output. Combined United States and Mexican output for October was 54,989 tons, against 54,692 tons in the preceding month.

Production of zinc in September, October, and the January-October period, in tons, follows:

	Sept.	Oct.	Jan.-Oct.
U. S.	53,285	(a) 50,938	531,852
Canada	7,674	6,247	72,628
Mexico	1,407	(a) 4,051	16,054
Belgium	17,545	18,832	181,830
France	7,220	8,279	82,975
Germany	9,648	9,933	96,984
Great Britain	5,281	5,611	55,322
Netherlands	2,144	2,200	23,380
Poland	16,695	16,985	163,747
Spain	1,118	1,111	10,812
Australia	4,838	5,104	47,909
Rhodesia	1,260	1,406	11,141
Elsewhere	5,000	5,000	48,500
World's total	133,115	135,697	1,343,134

(a) Up to October, 1929, slab zinc produced in the United States from Mexican ore was included in the United States statistics.

U. S. Arsenic Production Increased in September

ARSENIC production in the United States in September amounted to 1,027 tons of crude and 868 tons of refined, which compares with 887 tons of crude and 857 tons of refined in August. Stocks of crude arsenic at the end of September totaled 1,777 tons, against 1,876 tons a month previous, and 2,978 tons a year ago, according to the American Bureau of Metal Statistics. Stocks of refined on Sept. 30 totaled 3,180 tons, against 3,414 tons in the preceding month, and 1,071 tons on Sept. 30, 1928.

Imports of white arsenic during September were 1,281 tons. Of this total, 66 tons were from Canada; 1,121 tons from Mexico; 60 tons from Belgium; 6 tons from Germany; and 28 tons from Japan. Total imports for the first nine months of the year were 10,059 tons, which compares with 8,359 tons in the corresponding period last year.

ANGLO-CHILEAN CONSOLIDATED NITRATE CORPORATION for the six months ended June 30 shows gross earnings of $2,363,774, against $1,974,118 for the same period in 1928. After deducting taxes, interest on British and American debentures, and other charges, and allowing for depreciation and depletion, there was a deficit of $1,331,759.

Gain in Construction by Utilities

EXPENDITURE in 1930 of $1,400,000,000 in new construction and expansion is contemplated by the electric light and power, the manufactured and natural gas and the electric railway utility companies. President Hoover was informed of this program Nov. 27 at a conference with the public utility representatives, according to a statement issued after the conference at the White House. The sum involved represents an increase of $110,000,000 over the amount expended in 1929 for new construction and expansions by these utilities. An additional $410,000,000 will be expended in 1930 by the three groups for maintenance of existing properties.

Ontario's Metal Output in First Nine Months Gains

PRODUCTION of the metallic group of the mineral industry of Ontario during the first nine months of the current year shows a gain in value of $8,767,568, or 17.3 per cent above the figures for the corresponding period last year. The nickel-copper section accounted for the major portion of the increase, and including platinum and precious metal byproducts, was up 31.2 per cent from 1928.

Gold mining, according to returns received by the Ontario Department of Mines, showed a gain of $1,028,250. The loss of the Dome mill by fire on Oct. 28 will make for a decrease of more than $300,000 a month until such time as a new plant is constructed or temporary milling arrangements are effected. Silver, despite the low price, registered a fair gain in value compared with the 1928 period. Lead was down both as to quantity and value. Cobalt production shows a substantial increase over the figures for last year.

Ontario's Metal Production—First Nine Months 1928 and 1929

Product	Quantity		Value	
	1928	1929	1928	1929
Gold, oz.	1,146,888	1,196,631	$23,708,312	$24,736,562
Silver, oz.	5,342,838	6,501,310	3,103,009	3,540,391
Platinum metals, oz.	12,327	14,599	679,761	528,201
Copper, metallic, tons	14,136	24,195	4,037,298	8,826,048
Copper in matte exported (a), tons	9,427	5,846	1,885,387	1,753,810
Nickel in matte exported (a), tons	14,009	8,194	5,043,326	2,949,658
Nickel, metallic, tons	16,968	26,227	8,633,109	12,864,312
Nickel oxide, lb.	9,103,479	10,505,354	2,134,005	2,417,474
Nickel content of sales and residues, lb.	166,665	203,461	42,163	56,318
Cobalt, metallic and metal content of oxides, salts and unseparated oxides, lb.	460,995	703,694	1,090,130	1,379,829
Bismuth, lb.	7,957	21,061	8,302	18,733
Lead, pig, and in concentrates exported, lb.	5,241,910	3,946,038	310,508	251,684
Zinc in concentrates exported, lb.	.....	1,813,285	.....	119,858
Total	.....	.....	$50,675,310	$59,442,878

(a) Copper and nickel in matte valued at 10 and 18c. per pound, respectively, in 1928, and at 15 and 18c. in 1929.

Treadwell-Yukon Issues Preferred Stock

THE Treadwell-Yukon Company, Ltd., an operating company owned largely by Bunker Hill & Sullivan, Alaska-Treadwell, and Alaska Mexican, has been authorized by the Corporation Commission of California to issue to common shareholders 100,000 shares of preferred stock, par value $100 each. The preferred shares are 6 per cent cumulative.

According to company officials the purpose of the new issue is to reduce indebtedness and provide funds for expansion.

Engels Copper Profit Up

Engels Copper Mining Company, controlled by the California Copper Corporation, reports September profit of $35,132 after expenses, taxes, interest, and expenditures for developments, but before depreciation and depletion, against $10,587 in September of last year. For the nine months ended Sept. 30, profit on the same basis amounted to $396,847, compared with $89,923 in the first nine months last year.

AHUMADA LEAD COMPANY reports gross receipts for the nine months ended Sept. 30 of $663,993. After deducting depreciation, taxes, and all other expenses, the net loss for the period was $32,170. Cash and cash assets at the close of the period totaled $205,381.

London Financial News

W. A. Doman
Special London Correspondent

London, Nov. 19, 1929 — The New York Stock Exchange having rallied somewhat, the public on this side has become less pessimistic, and there is a slight disposition to pick up mining shares. Officials connected with base-metal producing companies, however, are not in quite so cheerful a mood. They have seen metal prices fall, and they do not yet foresee a recovery. With the long-distance telescope they look at New York, and fear not only a slowing down of industry on your side, but also here. Discussing the position today with a well-known official, he expressed the view that we are in for six or nine months of bad trade. If trade slows down, said he, then the demand for metals cannot increase, and it is poor enough now. Whether we talk about copper or tin, the case is the same.

Questions are being asked as to what the Tin Producers' Association is doing. As one mining engineer remarked to me yesterday, the T.P.A. knows how much tin certain people have been carrying; these people expected the T.P.A. to come along with a relief scheme, and such a scheme is farthest from their mind. Their attitude, I am told, is "Get out of the mess you got into, and then come along to us, and we will see what can be done, but we are not putting up money to ease your position." I am told that the best shares can safely be held, and that the future, for Malayan companies at least, is quite bright. Nigerian companies hardly count nowadays. As a cynic observed, we have two bodies, the Nigerian Chamber of Mines and the T.P.A.; and they appear to be more of a mutual admiration society than anything else! There is nothing of this about Rhodesian copper undertakings. Sir Edmund Davis and A. Chester Beatty do work, even if the finance companies with which they are associated sell shares when the merits of companies are being extolled. Finance companies are expected to make profits for their shareholders, and this is not done by waiting for dividends.

The report and accounts of the Burma Corporation for the twelve months to June 30 last are now in the hands of the shareholders. Ore reserves have been substantially increased in spite of the extraction of a record tonnage; metallurgical efficiency has attained a higher standard, and treatment costs have been reduced to the lowest figure yet recorded. The financial results are the best hitherto obtained, and larger dividends have been paid. Ore reserves are estimated at 4,140,969 tons assaying 21.2 oz. silver, 25.9 per cent lead, and 15.8 per cent zinc. An attempt is being made to raise the price of zinc.

At the Roan Antelope annual meeting on Nov. 25, the chairman is expected to make a statement concerning the ore reserves. Drilling results, says Mr. Irwin, have given most satisfactory indications.

Turner & Newell, the asbestos manufacturers, are proposing to absorb the Rhodesian and General Asbestos Corporation, on the basis of five Turner & Newall for four Rhodesian & General Asbestos shares.

The Mount Lyell Mining & Railway Company, Australia, reports that operations for the year ended Sept. 30 resulted in a net profit of £324,128 after allowing for prospecting and development, depreciation, and taxation. Credit balance to profit-and-loss account was £743,948. Surplus liquid assets are £420,608, exclusive of shares in other companies. A dividend of 1s. 3d. and a bonus of 1s. 6d. per share have been declared, payable on Oct. 18, making with the interim dividend of 1s. 3d. per share paid on June 24, a total distribution of 4s. per share for the year.

Imports and Exports of Ores and Metals in October, 1928 and 1929

Compiled from U. S. Department of Commerce Records

In Pounds, Unless Otherwise Stated

Imports

	October 1928	October 1929
Antimony		
Ore — Gross weight	837,448	236,770
Ore — Antimony content	450,050	144,110
Copper		
Ores, copper content	8,171,439	9,267,313
Concentrates, copper content	3,493,570	3,993 003
Regulus, coarse metal, cement copper	110,500	176,515
Imported from:		
Spain	1,071,903	653,548
Canada	5,891,410	7,076,827
Mexico	2,105,654	3,538,247
Cuba	1,601,400	.....
Chile	832,835	943,830
Peru	56,811	132,173
Other countries	215,496	1,092,206
Unrefined converter copper in pigs, bars, and other forms	54,213,116	61,220,433
Refined copper	9,278,160	10,337,020
Old and clippings	1,154,976	1,523,617
Composition metal	8,960	.....
Brass, old, for remanufacture	1,290,181	1,084,889
Lead		
Ore and matte, lead content	4,211,625	3,441,218
Bullion or base bullion	26,481,871	9,062,218
Pigs and bars, and old scrap, lead content	5,975	.....
Type metal, antimonial lead — Lead content	941,088	.....
Type metal, antimonial lead — Gross weight	730,210	.....
Manganese, tons		
Cuba, manganese content	111	40
Other countries, manganese content	26,031	24,827
Pyrites, tons	44,686	35,385
Tin, ore, tons	6	18
Bars, blocks, pigs	18,027,677	13,889,432
Imported from:		
Netherlands	2,197,167	310,259
United Kingdom	848,713	2,579,895
British Malaya	14,507,608	10,359,402
Netherlands East Indies	115,225	23,163
Hongkong	33,893	515,839
Australia	112,020	100,800
Other countries	213,049	74
Zinc		
Ore, zinc content — Free	.....	.....
Ore, zinc content — Dutiable	182,392	110,625
Blocks, pigs and other forms, old	703	97

Exports

	October 1928	October 1929
Copper		
Ores, composition, concentrates, unrefined	5,200	2,240
Refined copper, in ingots and other forms	76,295,470	76,574,109
Exported to:		
Belgium	4,230,477	3,665,278
France	19,699,313	17,294,341
Germany	20,919,076	14,532,675
Italy	6,646,485	6,942,444
Netherlands	3,453,098	1,958,908
Spain	292,280	67,415
Sweden	2,002,818	2,914,983
United Kingdom	15,046,828	16,682,998
Other Europe	987,221	998,777
Canada	1,204,443	7,139,343
China, Hongkong, Kwantung	49,280	.....
Japan	1,007,814	.....
Other countries	756,337	4,376,947
Old and scrap	5,611,264	1,803,594
Pipes and tubes	311,408	258,021
Plates and sheets	421,052	426,905
Rods	5,798,305	9,057,191
Insulated copper wire and cables	1,844,471	1,845,383
Lead		
In pigs, bars and other forms	20,895,732	10,137,371
From foreign ore	17,973,792	10,038,909
From domestic ore	2,921,940	98,462
Exported to:		
Belgium	112,024	.....
France	224,097	467,904
Germany	2,924,159	739,389
Netherlands	571,387	91,042
Sweden	1,423,005	789,349
United Kingdom	9,746,113	1,458,652
Other Europe	1,512,509	1,210,13
Brazil	291,350	239,022
Other South America	76,684	201,450
China, Hongkong, Kwantung	1,008,737	.....
Japan	2,801,265	3,753,692
Other countries	204,402	1,191,688
Other lead manufactures	1,580,976	349,051
Zinc		
Ores and concentrates, tons	.....	.....
Dross	216,239	495,487
Cast in slabs, blocks and pigs	1,767,723	2,976,045
Exported to:		
Belgium	.....	64,933
France	448,064	112,009
Germany	472,407	.....
Netherlands	151,574	250,602
United Kingdom	112,055	2,016,979
Other Europe	168,436	15,680
Japan	112,020	.....
Other countries	303,167	515,842
Sheets, strips and other forms	979,411	884,013
Dust	38,812	196,570
Other zinc manufactures	132,269	79,469

Metal Statistics

Monthly Average Prices of Metals

Silver

	New York		London Spot		Sterling Exchange	
	1928	1929	1928	1929	1928	1929
January	57.135	57.019	26.313	26.257	487.098	484.577
February	57.016	56.210	26.205	25.904	487.008	484.787
March	57.245	56.346	26.329	26.000	487.558	484.776
April	57.395	55.668	26.409	25.738	487.785	484.808
May	60.298	54.125	27.654	25.084	487.685	484.599
June	60.019	52.415	27.459	24.258	487.565	484.330
July	59.215	52.510	27.262	24.289	485.923	484.560
August	58.880	52.579	27.096	24.288	484.979	484.368
September	57.536	51.042	26.440	23.708	484.654	484.253
October	58.087	49.913	26.727	23.042	484.584	486.392
November	57.953	49.615	26.704	22.690	484.492	487.104
December	57.335	.....	26.349	.....	484.698	.....
Year	58.176	.....	26.746	.....	486.169	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine.

Copper

	New York		London Spot			
	Electrolytic		Standard		Electrolytic	
	1928	1929	1928	1929	1928	1929
January	13.854	16.603	61.912	75.551	66.575	78.602
February	13.823	17.727	61.670	78.228	66.381	83.538
March	13.845	21.257	61.148	89.153	66.443	98.356
April	13.986	19.500	61.678	81.036	66.500	89.405
May	14.203	17.775	62.554	75.026	67.216	83.727
June	14.527	17.775	63.664	74.338	68.738	84.013
July	14.527	17.775	62.881	72.152	68.670	84.043
August	14.526	17.775	62.472	73.783	68.750	84.250
September	14.724	17.775	63.522	75.286	69.800	84.363
October	15.202	17.775	65.524	72.815	71.935	83.978
November	15.778	17.775	68.080	69.324	74.750	82.202
December	15.844	.....	69.336	.....	75.000	.....
Year	14.570	.....	63.703	.....	69.230	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1928	1929	1928	1929	1928 Spot	1928 3 Mos.	1929 Spot	1929 3 Mos.
January	6.500	6.650	6.280	6.498	21.773	22.213	22.111	22.344
February	6.325	6.853	6.069	6.739	20.283	20.747	23.128	23.156
March	6.000	7.450	5.805	7.348	19.938	20.352	25.409	25.591
April	6.100	7.187	5.991	7.025	20.306	20.563	24.783	24.408
May	6.123	7.000	6.012	6.761	20.483	20.813	23.949	23.750
June	6.300	7.000	6.152	6.790	20.985	21.211	23.694	23.603
July	6.220	6.804	6.038	6.607	20.602	20.957	22.810	22.880
August	6.248	6.750	6.056	6.553	21.634	21.628	23.185	23.259
September	6.450	6.890	6.286	6.689	22.050	21.769	23.557	23.589
October	6.500	6.873	6.318	6.674	22.082	21.796	23.226	23.253
November	6.389	6.285	6.222	6.135	21.239	21.469	21.622	21.643
December	6.495	.....	6.343	.....	21.342	21.730	.....	.....
Year	6.305	.....	6.131	.....	21.060	21.271	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York		London	
	1928	1929	1928	1929
	Straits		Spot	
January	55.650	49.139	253.222	222.727
February	52.440	49.347	233.833	223.138
March	52.220	48.870	232.722	220.781
April	52.270	45.858	234.204	206.887
May	51.582	43.904	230.886	197.545
June	47.938	44.240	217.280	200.206
July	47.040	46.281	212.449	209.473
August	48.012	46.619	212.847	209.815
September	48.073	45.359	215.663	204.863
October	48.966	42.290	222.005	190.783
November	50.750	40.208	232.875	180.565
December	50.185	.....	227.586	.....
Year	50.427	.....	227.131	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1928	1929	1928 Spot	1928 3 Mos.	1929 Spot	1929 3 Mos.
January	5.643	6.350	26.125	26.051	26.196	26.233
February	5.551	6.350	25.518	25.506	26.247	26.347
March	5.624	6.463	25.082	24.960	27.050	27.294
April	5.759	6.658	25.493	25.316	26.759	26.613
May	6.026	6.618	26.102	25.756	26.727	26.619
June	6.158	6.686	25.664	25.429	26.216	25.984
July	6.201	6.766	24.946	24.972	25.332	25.418
August	6.249	6.800	24.540	24.713	24.896	25.164
September	6.250	6.799	24.497	24.625	24.208	24.688
October	6.250	6.740	24.030	24.296	22.927	23.329
November	6.263	6.242	24.801	24.827	20.851	21.351
December	6.349	.....	26.609	26.615	.....	.....
Year	6.027	.....	25.284	25.256	.....	.....

St. Louis quotations, cents per pound. London pounds sterling per long ton.

Antimony, Quicksilver and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) Refined New York		Platinum (c) Crude New York	
	1928	1929	1928	1929	1928	1929	1928	1929
Jan.	10.863	9.558	123.620	119.481	79.280	70.000	69.280	60.000
Feb.	10.842	9.548	121.370	119.818	84.783	70.000	74.783	60.000
March	10.083	9.531	122.557	121.904	80.000	70.000	70.000	60.000
April	9.865	9.462	123.740	122.000	80.000	70.000	70.000	60.000
May	11.019	8.957	123.173	121.154	78.000	68.615	68.000	58.615
June	9.750	8.845	122.423	120.500	78.000	68.000	68.000	58.000
July	9.540	8.543	121.260	121.654	78.000	68.000	68.000	58.000
Aug.	10.181	8.778	124.500	125.111	78.000	68.000	68.000	58.000
Sept.	10.813	8 709	128.000	124.542	78.000	66.000	68.000	56.000
Oct.	10.841	8.538	125.923	124.298	78.000	65.000	68.000	55.000
Nov.	10.109	8.583	123.000	123.323	76.417	65.000	66.418	55.000
Dec.	9.748	.....	122.500	.....	74.480	.....	64.480	.....
Year.	10.305	.....	123.506	.....	78.580	.....	68.580	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce.

Pig Iron[1] and Aluminum

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1928	1929	1928	1929	1928	1929	1928	1929
Jan.	17.50	18.00	17.00	17.50	17.25	17.50	24.300	24.300
Feb.	17.50	18.00	17.00	17.50	17.25	17.50	24.300	24.300
March	17.50	18.19	17.00	17.62	17.25	17.69	24.300	24.300
April	17.50	18.50	17.00	18.00	17.25	18.00	24.300	24.300
May	17.37	18.81	16.38	18.31	17.24	18.31	24.300	24.300
June	17.00	19.00	15.56	18.50	16.79	18.50	24.300	24.300
July	17.00	19.00	15.75	18.50	16.69	18.50	24.300	24.300
Aug.	17.00	19.00	15.75	18.50	16.50	18.50	24.300	24.300
Sept.	17.00	19.00	15.75	18.50	16.50	18.50	24.300	24.300
Oct.	17.24	19.00	16.66	18.50	16.74	18.50	24.300	24.300
Nov.	17.82	19.00	17.32	18.50	17.32	18.50	24.300	24.300
Dec.	18.00	.....	17.50	.....	17.50	.. ..	24.300	.....
Year.	17.37	.....	16.56	.....	17.02	.....	24.300	.....

Iron in dollars per long ton. Aluminum in cents per pound, 99 per cent grade.

[1]F.o.b. Mahoning and Shenango valley furnaces; freight to Pittsburgh, $1.76.

Monthly Crude Copper Output in Short Tons

Domestic

	1928 Total	1929 May	June	July	Aug.	Sept.	Oct.
Alaska shipments	22,724	1,801	1,793	1,514	893	3,282	1,203
Calumet & Arizona	65,182	6,731	5,286	4,986	5,262	4,926	5,206
Magma	18,251	2,022	1,664	1,616	1,585	1,729	1,660
Miami	24,129	2,416	2,416	1,763	2,317	2,186	3,350
Nevada Con.	134,231	.....	†36,309	.....	.....	†30,095	.....
Old Dominion*	11,069	1,022	782	898	954	932	1,003
Phelps Dodge††	102,137	9,857	8,901	9,274	9,144	9,126	8,534
United Verde Extens.	22,073	2,732	2,510	2,235	2,296	2,570	3,019
Utah Copper	136,920	.....	†42,310	.....	.....	.....	.....
Tennessee Copper	6,792	676	638	677	659	660	678

Foreign

Andes Copper	52,029	7,393	6,871	7,445	6,625	6,538	.....
Braden	109,137	7,630	7,630	7,620	7,628	7,656	.....
Boleo, Mexico	12,782	.....	†3,637	.....	.....	†3,107	.....
Bwana M'Kubwa	6,696	317	536	561	593	541	665
Chile	132,932	14,852	12,060	11,044	11,042	11,021	.....
Furukawa, Japan	17,865	1,600	1,506	1,260	1,425	.....	.....
Granby Cons., Canada	28,767	2,591	2,518	2,467	2,510	2,718	2,666
Howe Sound	21,099	.....	†5,452	.....	.....	†5,361	.....
Messina	.....	.....	651	654	667	657	557	590
Mt. Lyell	6,582	525	548	600	800	815	.....
Sumitomo, Japan	17,898	1,718	.....	.....	1,532	1,352	.....
Union Miniere, Africa	123,880	13,224	12,673	13,216	13,444	14,106	13,995

†Three months. *Includes Arizona Commercial.
††Moctezuma is included.

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1927 Monthly Production	1927 Daily Rate	1928 Monthly Production	1928 Daily Rate	1929 Monthly Production	1929 Daily Rate
January	76,198	2,458	68,469	2,209	86,325	2,785
February	69,202	2,472	67,423	2,352	84,735	3,026
March	69,314	2,236	70,327	2,269	93,698	3,023
April	71,122	2,371	69,721	2,324	94,902	3,163
May	71,613	2,310	73,729	2,378	93,392	3,013
June	69,539	2,318	73,224	2,441	82,354	2,745
July	65,545	2,114	73,426	2,369	79,229	2,556
August	67,248	2,169	76,952	2,482	78,885	2,545
September	65,936	2,198	78,341	2,611	79,402	2,647
October	68,545	2,225	86,480	2,790	82,575	2,664
November	68,080	2,269	85,382	2,846	.....	.....
December	67,377	2,173	85,677	2,764	.....	.....
Total	829,978	.....	909,051	.....	855,497	.....
Monthly average	69,165	.....	75,754	.....	85,550	.....
Average of daily rate	.....	2,274	.....	2,484	.....	2,814

The Market Report

Lead Still Most Active Metal

New York, Dec. 4, 1929.—The volume of business in non-ferrous metals was extremely light in the last week, indicating that consumers are holding down purchases to a minimum as the end of the year is approaching.

Copper was dull throughout the period, but the price held on the basis of 18c., delivered in Connecticut. Hardly any change occurred in the general situation, with consumers restricting purchases to immediate needs only. Offerings of copper by second-hands were even smaller than a week ago, and in producing circles it was felt that the total tonnage of such metal that reached the market was comparatively limited. Foreign buying also was slow. Export business booked in November amounted to about 21,500 tons. Export sales for the first three days of December totaled 1,800 tons. Interest centers in the statistical position of the market. The November statistics, to be issued shortly, are expected to show a substantial increase in stocks of refined copper. In view of the extremely limited demand for copper which has obtained for some weeks now, coupled with the fact that the November production of refined does not reflect the recent drop in mine output, no special significance is attached to the prospects for an increase in stocks.

Zinc business was quiet and prices were unsettled. On Monday one lot sold at 5.90c., St. Louis, though most sellers quoted the market at 6c. Later prices appeared to be a shade firmer, business passing at 5.95c. and also 6c. The market abroad was rather easy. The European Cartel came to no agreement at its recent meeting, and it was decided to name a committee to draft new regulations which are to be submitted at the next meeting, scheduled to take place about the middle of this month.

Though lead continues in considerably greater demand than any other of the non-ferrous metals, the tonnage sold for the week ending today was well below last week's total. Monday's business was excellent, but the demand on other days was inactive. Demand was largely from cable manufacturers, corroders, and sheet and pipe manufacturers. Producers are well satisfied with recent business, one reporting that more lead has already been contracted for the coming year than has ever been booked at this time of the year before. Current production is well sold up, and the market is stable in London at well above import parity for bullion, so producers feel that domestic prices are likely to be stable throughout December.

Daily Prices of Metals

Nov. Dec.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
28	Holiday	.....	....	.....	.....
29	17.775	39.75	6.25	6.10	6.00
30	17.775	40.00	6.25	6.10	6.00
2	17.775	38.875	6.25	6.10	5.90@6.00
3	17.775	39.375	6.25	6.10	5.95@6.00
4	17.775	38.875	6.25	6.10	5.95@6.00
	17.775	39.375	6.250	6.100	5.980

Average prices for calendar week ending November 30, 1929, are: Copper, 17.775c.; Straits tin, 40.775c.; New York lead, 6.250c.; St. Louis lead, 6.100c.; zinc, 6.045c.; and silver, 49.475c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. Contract prices for High-Grade zinc delivered in the East are 1@1.15c., depending upon purity, above St. Louis prices for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Nov. Dec.	Copper		Electrolytic	Tin		Lead		Zinc	
	Standard								
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
28	69½	68⅝	83	176½	179½	21 7/16	21 7/16	19⅝	20⅜
29	69¼	68 3/16	83	179¾	182¾	21½	21½	19⅝	20 3/16
2	68¾	67⅞	83	174¼	177¼	21 5/16	21 7/16	19¾	20⅜
3	67⅞	67⅜	83	177¾	180¾	21¼	21 5/16	20	20⅛
4	68⅛	68 13/16	83	176½	179½	21 5/16	21 7/16	20 3/16	20 13/16

Prices for lead and zinc are the official closing prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

Silver, Gold, and Sterling Exchange

Nov.	Sterling Exchange "Checks"	Silver		Gold London	Dec.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
28	Holiday	....	22½	84s11½d	2	$4.87¼	49¼	22½	84s11½d
29	$4.87¼	49¼	22 9/16	84s11½d	3	4.87¾	49⅛	22 7/16	84s11⅜d
30	4.87¼	49⅛	22 9/16	.....	4	4.87 9/16	49⅛	22 7/16	84s11½d

Average: Silver, 49.275c.; Sterling Exchange, $4.8734

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Average Metal Prices for November, 1929

COPPER:	
New York Electrolytic	17.775
London Standard Spot	69.324
London Electrolytic Spot	82.202
LEAD:	
New York	6.285
St. Louis	6.135
London Spot	21.622
London Forward	21.643
SILVER:	
New York	49.615
London	22.690
Sterling Exchange	487.104
ZINC:	
St. Louis	6.242
London Spot	20.851
London Forward	21.351
TIN:	
Straits	40.208
London Standard Spot	180.565
QUICKSILVER	123.323
ANTIMONY	8.583
PLATINUM:	
Refined	65.000
Crude	55.000
ALUMINUM 99 Per Cent Plus	24.300

Prices quoted by all sellers continue at 6.10c., St. Louis, for chemical lead, and 6¼c., New York, for desilverized, which latter is also the contract price of the A. S. & R. Corroding grades command premiums of $2@$3 per ton.

The drop below 40c. again stimulated some interest in tin, sales to tin-plate manufacturers being very satisfactory on Monday, but today the market has again relapsed into quietness, at 38¾c. for spot Straits. Futures are nominally about ⅞c. higher. No particular element of strength appears in the situation.

Continued weakness on the part of China and India has again depressed silver. At these lower quotations, the market appears steady, although the future is still uncertain.

Mexican Dollars (old Mexican pesos): Nov. 28th, holiday; 29th, 36⅝c.; 30th, 36½c.; Dec. 2d, 36⅜c.; 3d and 4th, 36¼c.

Closing cable quotations on the principal Continental exchanges on Tuesday, Dec. 3, were: Francs, 3.93⅛c.; lire, 5.23¾c.; and marks, 23.95c. Canadian dollars, ⅛ per cent discount.

Correction

The quotation for spot Straits tin in New York on Nov. 27 was erroneously published last week as 41.50c.; the correct figure was 40.50c. The average price of St. Louis zinc for the week ending Nov. 27 was 6.142c., instead of 6.14c. as printed in some copies.

November Closes With Steel Output Under 70 Per Cent

Pittsburgh, Dec. 3, 1929.

November opened with steel ingot production at about 80 per cent of capacity and closed with a rate slightly under 70 per cent. The decrease was made up of three elements: Gradual recession of bulge in production above the general trend line, which began in July of 1928; normal seasonal decrease; influence of the crash in the stock market.

October and November production ran below the same months of last year. Steel output for the twelve months ended Sept. 30 was about 56,750,000 long tons, against 50,325,393 tons in the calendar year 1928, and an indicated total of about 55,500,000 tons for 1929.

Automobile production is seasonally light in November and December, but this year has seen much more than the seasonal decline. Various other industries also have witnessed seasonal declines. Four lines, however, show no decline, namely, rails, fabricated structural steel, freight cars, and farm impliments.

Finished-steel prices are hardly firm, but they show no quotable declines except in galvanized sheets, $2 a ton to 3.40c., and in cold finished bars, $2 a ton to 2.20c.

Pig Iron—All markets have been dull, and the Valley market practically stagnant, but there have been no price declines in any district. Prices, f.o.b. Valley furnaces: Bessemer and malleable, $19; basic and foundry, $18.50.

Connellsville Coke—The Frick Company (Steel Corporation) has blown out almost all its ovens in the Connellsville region and merchant operators have curtailed production. Spot furnace coke is easier at $2.60 per ton at ovens, and foundry is unchanged at $3.75 to $4 for ordinary standard brands.

Tri-State Zinc Cut $2

Joplin, Mo., Nov. 30, 1929

Blende

	Per Ton
High	$41.85
Premium blende, basis 60%..	38.00
Prime Western, basis 60%...	$37.00@ 38.00
Table concentrate, 60%.....	36.00@ 37.00
Flotation concentrate, 60%..	34.00@ 35.00
Average settling price, all...	39.10

Galena

High	$78.25
Basis 80% lead.....	75.00
Average settling price.....	76.62

Shipments for the week: Blende, 6,853; galena, 760 tons. Value, all concentrates the week, $326,200.

Zinc concentrate production was lowered this week to 54 per cent of normal, with only 73 mines producing. Of this number nearly half were operated on part time. A reduction of $2 per ton in the price of zinc concentrate was made. Only a few of the mines now idle, which produce zinc ore alone, can resume production with profit.

The basis price of $75 per ton was retained on lead. As only a few producers accepted this offer, the lead shipment dropped to the lowest tonnage of any one week for several years, with one exception.

Platteville, Wis., Nov. 30, 1929

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc.....	$40.50
Lead Concentrate	
Lead, basis 80 per cent.....	$75.00

Shipments for the week: Blende, 575 tons; lead, none. Shipments for the year: Blende, 30,799; lead, 1,935 tons. Shipments for the week to separating plants, 1,197 tons blende.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c. London, 98 per cent, quoted at £95 per long ton, less 2 per cent for domestic consumption.

ANTIMONY—Per lb., duty paid: Chinese brands, for all positions, 8½c. Trading quiet, but with no change in the Chinese market, prices are holding steady. Cookson's "C" grade, spot, 14c. Chinese needle, lump, 8c. Standard powdered needle, 200 mesh, 10c.

BISMUTH—Per lb., in ton lots, $1.70. Smaller lots $1.85 and up. London 7s. 6d.

CADMIUM—Per lb., 80@90c. London, 3s.10d.@3s.11d. for prompt.

CHROMIUM—Per lb., 97@98 per cent grade, 95c.@$1.

COBALT — Per lb.. f.o.b. Canadian works: Shot or rondelles, 97@98 per cent, $2.50. Contract sales booked at discounts, depending on quantity. Black oxide, 70 per cent, $2.10. London, nominal, 10s. for metal in small lots, 8s. for black oxide; 8s. 10d. for gray.

[1]GERMANIUM DIOXIDE—Per gram in 200- to 300-gram lots, $3.50.

IRIDIUM—Per oz., $210@$220 for 98 @99 per cent sponge and powder. London, £43@£46.

[1]LITHIUM—Per oz., 98@99 per cem grade in 1- to 5-lb. lots, $3.

MAGNESIUM—Per lb., single orders for spot metal: 8-lb. ingots (3x3x15 or 16 in.), 95c.@$1.05, depending on quantity; 2½- or 3-lb. sticks (1⅜ in.) 90c.@$1.10, depending on quantity; 10-oz. sticks (1x12 in.), 80@90c. Discounts up to 20 per cent on larger orders or contracts. London 3s. 3d.@ 3s. 6d. for 99 per cent ingots or sticks.

[1]MOLYBDENUM—Per lb. in 50- to 100-lb. lots, 99 per cent, $11. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb., ingot 35c.; shot 36c.; electrolytic, 35c. (99.90 per cent), for single lots of spot metal. London, per long ton, £170@£175. Demand good and market is firm, according to *The Metal Bulletin*, London.

OSMIUM—Per oz., $58@$65; London, £13@£13 10s.

PALLADIUM—Per oz., $35@$36; London, £6 15s.@£7.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $65. Transactions between dealers and refiners in the outside market are commonly reported at several dollars less. London, per oz., £13 5s.@£13 10s. for refined; crude and scrap, nominal at £11@£11 15s.

QUICKSILVER — Per 76-lb. flask, $122@$123.50. Market quiet and prices unsettled. San Francisco wires $126. London steady, with offers of near-by at £22 17s. 6d.

RADIUM — Per mg. radium content, $70.

RHODIUM—Per oz., $45@$55. Nominal. London, £11 10s.@£13.

RUTHENIUM — Per oz., $42@$50. Nominal. London £9@£10 10s.

SELENIUM—Per lb. in 500-lb. lots; Black, powdered, amorphous, 99.5 per cent pure, $2. London, 7s. 8d.@ 7s. 9d.

TANTALUM — Per gram: Bar and heavy sheet, chemically pure, 16c.; tantalum powder, 11c.

TELLURIUM—Per oz., 15@18c.

THALLIUM METAL—$12.50@$15 per pound.

TITANIUM—Per lb., 80@90 per cent grade, $5.

TUNGSTEN POWDER—Containing 98 per cent tungsten, per lb., $1.70@$1.75.

VANADIUM—Per gram, 92@95 per cent grade, $1.20@$1.25.

---

[1]Price furnished by Foote Mineral Company, Philadelphia.

Metallic Ores

ANTIMONY ORE—Bolivian ore, 60 per cent metallic antimony, $1.30 per short ton unit, c.i.f. New York.

CHROME ORE—Per long ton, f.o.b. Eastern shipping points, Indian and Rhodesian ores, $21.50 for 46@47 per cent Cr_2O_3 ore, and $24 for 50@51 per cent ore. New Caledonian ore, high-grade, $25.

IRON ORE—Per long ton, lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 9c.

Foreign ores, f.o.b. cars Atlantic ports, cents per unit:

North African, low-phosphorus, 12½c.

Spanish and North African basic, 55@60 per cent, 11½@12c.

Swedish foundry or basic, 66@68 per cent, 10½c.

Newfoundland foundry, 55 per cent, 8½@9c. Nominal.

MANGANESE ORE—Per long-ton unit of Mn, c.i.f. North Atlantic ports. Exclusive of duty. Brazilian and Indian ores, minimum 47 per cent Mn, 31@34c. Caucasian, 53@55 per cent, 36c. Cuban, minimum 47 per cent, 35c. Chilean, minimum 47 per cent, 34c.

Per ton in carload lots:

[1]Chemical grades, powdered, coarse or fine, 82@87 per cent MnO_2, Brazilian, Javan, Caucasian, and Cuban, $60@$65. Domestic, 70 to 72 per cent, $40@$50.

TANTALUM ORE—Per unit of Ta_2O_5, basis 60 per cent ore, $13.

TITANIUM ORE—Ilmenite, per gross ton, 50 per cent TiO_2, f.o.b. Atlantic seaboard, $9.50@$11, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7@$8 per gross ton. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c. in carload lots.

TUNGSTEN ORE—Per short-ton unit of WO_3, N. Y.: Wolframite, 15.25 for future delivery. Market steady. Bolivian scheelite is quoted at $15.25, Dec.-Jan. shipment. Western scheelite, $16.50, Jan. shipment.

VANADIUM ORE—Per lb. V_2O_5 contained, 28c.

ZIRCON ORE—Per net ton containing 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

[1]Price given by Foote Mineral Company, Philadelphia.

[1]AMBLYGONITE—Per ton, f.o.b. mines: 8@9 per cent lithium oxide, $50@$60.

ASBESTOS — Per ton: f.o.b. Quebec mines, tax and bags included, prices quoted by leading interest for delivery on 1929 contract:

Crude No. 1, $550@$750; crude No. 2, $450@$575; spinning fibers; $225@$275; magnesia and compressed sheet fibers, $175@$225; shingle stock, $55@$115, various grades; paper stock, $45@$50; cement stock, $25; short fibers, $10@$20; floats, $12@$15. Europe reports a general shortage of Canadian spinning fiber and No. 2 crude.

Per ton c.i.f. New York: Rhodesian crude No. 1, $450; No. 2, $350.

BARIUM CARBONATE (Witherite)—Per ton: 90 per cent, 200 mesh, $47; 100 mesh, $44.

BARYTES—Per ton: f.o.b. mines, bags extra:

Georgia: Barytes ore, crude (per long ton), $9. Washed and water floated to 97 per cent through 325 mesh, $18.

Missouri: Water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, 93 per cent $BaSO_4$, not to exceed 1 per cent iron, $7.75@$8 f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $7.50@$8.25 f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6.75@$8.25 f.o.b. *Arkansas* mines. Pulverized and dried, $12@$14 f.o.b. *Arkansas* mines; calcined, 78 to 84 per cent Al_2O_3, $18@$19 f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic port: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@$6.50; Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 5 per cent SiO_2, $6@$8.

BORAX—Per lb.: Carload lots, in bags, crystals, 2¾c.; granulated or powdered, 2½c.; f.o.b. shipping point.

[1]CELESTITE—Per ton in carload lots: 90 per cent $SrSO_4$, finely powdered, $27.

CHALK—Per ton: Crude in bulk, c.i.f. *New York,* $4.75@$5.

CHINA CLAY (KAOLIN)—Per ton: F.o.b. *Virginia* mines, crude lump, No. 1, $7; crude No. 2, $5.50; washed, $8; powdered and air-floated, $8@$15; ground, $7@$15.

Florida, pressed pottery, bulk, $13; ground, No. 1, $20; No. 2, $15. Sprayed mineral flour in 100-lb. bags (bags extra), No. 1, $20; No. 2, $17.

Best grade, domestic, $16@$18, f.o.b. *Delaware* plants in carload lots.

Imported English, f.o.b. American ports: Lump, $14@$20; powdered, $40@$45.

DIATOMITE—Per short ton, f.o.b. producing plant:

Kiln-fired brick, $65; kiln-fired aggregate, ¼ in., $45; insulating powder, $25; natural aggregate, ¼ in., $18@$20; air-floated powder, $45; 80 to 85 per cent silica, 98 per cent through 200 mesh, $20 in carload lots.

EMERY—F.o.b. *Pennsylvania* and *New York* in 350-lb. kegs, per lb.: Greek Naxos, 6½c.; Turkish, 6½c.; Khasia, 6½c.; domestic, 3½c.

FELDSPAR—F.o.b. mine or grinding plant:

North Carolina, per long ton, No. 1 pottery grade, crude, $6.50@$8; No. 2, glass grades, $5.50@$6.

No. 1, pottery, 140 mesh, $16; 200 mesh, $18. No. 2, enamel, 20 mesh, $10.25@$12; 140 mesh, $13.50@$16; 200 mesh, $15@$18; all per short ton.

New Hampshire, per ton: Pottery grade, $8. Best quality lump, $8.75.

New York, per ton: f.o.b. cars, No. 1 crude, $9. Soda-potash feldspar, 140 mesh, first grade, $16 per short ton; 200 mesh, first grade, $18.

Maine, per ton: Best pottery grade, ground, $19.

FLUORSPAR — Per ton: F.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $18. Foundry lump, 85-5, $20. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. Acid lump, 98-1, $30 in car lots.

New Mexico: 85-5 gravel, $16.50; 85-5 lump, $16; 94 lump, $21; ground, 97, $35.

Foreign spar, duty paid, $17, tidewater.

FULLER'S EARTH — Per ton, f.o.b. *Florida:* 16 to 30 mesh, $16.50; 30 to 60 mesh, $18; 16 to 60 mesh, $17; 60 to 90 mesh, $14; 100 mesh up, $7.

Powdered, import duty paid, $24@$26 per ton.

GARNET—Per ton; domestic, f.o.b. mines, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. mines *Colorado:*

Selected grade, $33; seconds (mine run), $25.50.

GRAPHITE—Per lb., f.o.b. *New York:*

Ceylon lump, 8@9c.; chip, 6½@7c.; dust, 3@5c.; Madagascar flake, 6@8c.

No. 1 flake, 8@16c.; fine ground, 5@15c. Ordinary fine ground, 3@6c.; high grade, 8@12c.; amorphous, 3@7c.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND—Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, depending upon location: Crushed, $1.50@$5; ground, $4@$9; agricultural, $4@$8; calcined, $4@$13.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

[1]LEPIDOLITE—Per ton: $20@$30 for ordinary grades. Nominal.

LIMESTONE—Per ton: f.o.b. shipping points, depending on location, either lump or crushed, 50c.@$3.

Agricultural, 75c. up to $5 for crushed or pulverized. Prices depend upon source, purity, and fineness.

MAGNESITE — Per short ton, f.o.b. *California* mines: Grade "A" calcined, 80 per cent through 200 mesh, $43; Grade B, $40; dead burned, $29; crude, $11. *Washington:* Dead-burned magnesite, $22@$24 per net ton, Chewelah, Wash.

MICA—Per ton, f.o.b. plant:

New Hampshire: Mine run sheet and punch, $320@$360; clean shop scrap, $22@$25; roofing, $30@$35. White dry ground, 20 mesh, $28; 40 mesh, $40; 60 mesh, white, $60; off-color, $34; 100 mesh, $65; 200 mesh, $80. Granite mica facings for cement block and stucco use, $8@$12, depending on size between ¼ in. and 60 mesh. Disks, 1¼ in. No. 1, per lb., $1.25; 2½x2 in. square cuts, $3.25.

North Carolina: White, ground, 20 mesh, $35; 70 mesh, $100.

Madagascar, amber, per lb., f.o.b. *New York*, duty paid: No. A1, $2.50; No. 1, $2; No. 2, $1.65; No. 3, $1.15; No. 4, 60c.; No. 5, 45c.

[1]MONAZITE—Per ton: (Minimum 6 per cent ThO_2), $60.

OCHER — F.o.b. *Georgia* mines, per ton: $19@$20 in sacks; $21@$22 in barrels; washed and water floated, $18; second grade, 99 per cent through 225 mesh, $18.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4. Dull.

Tennessee, ground, 80 per cent through 300 mesh, 33 per cent P_2O_5, $12.80 per short ton. Brown lump for acid manufacture, per gross ton, $6.50 on 75 per cent basis; $5.50 on 72 per cent basis. Non-acidulated, fine ground, 65 per cent, $8 (per short ton).

POTASH—The ruling contract prices (short tons) are as follows:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent..	$36.75	$35.15
Sulphate of potash, 90@95 per cent, basis 90 per cent	47.75	46.15
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.50	25.90
Manure salt, 30 per cent...	21.95	18.95
Manure salt, 20 per cent...	15.50	12.50
Kainit, 14@16 per cent ...	12.60	9.60
Kainit, 12.4 per cent.....	12.10	9.10

PUMICE STONE—Per lb.: In barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur: C.i.f. United States ports; guaranteed 48 per cent sulphur: Spanish, 13c.; Tharsis, furnace size, 2½ in. diameter, 14c. Cinder from ore to remain property of buyers.

[1]QUARTZ ROCK CRYSTALS—Per lb. in ton lots: Colorless, clear but flawed, pieces ¼ to ½ lb. in weight, 20c. Flawless, for optical purposes, four times above price; larger crystals still higher.

SILICA—Per ton: Water ground and floated, in bags, f.o.b. Illinois: 325 mesh, $18@$40 for 92 to 99½ per cent grades. Market steady. Glass sand, f.o.b. producing plant, 75c.@$5 per ton; molding sand, 65c.@$3.50; blast sand, $1.35 @$3.50.

[1]SPODUMENE — Per ton: $20@$30, depending upon lithium content.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC—Per ton, carload lots, f.o.b. works, containers included:

Vermont: 99 per cent through 200 mesh, extra white, $9@$9.50; 97½ to 98½ per cent through 200 mesh, medium white, $8.50@$9; packed in 50-lb. paper bags; prices $1 per ton less in burlap sacks plus 15c. net for bags packed 12 to the ton.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75@$15.25.

Georgia: Powdered, gray, $7.50@ $10; yellow, $9@$12; red, $11@$13; roofing, $7.50@$9.

New Jersey: Soapstone, ground, $10 @$12.

TRIPOLI—Per short ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $16. Double ground through 110 mesh, rose and cream, $18. Air-floated through 200 mesh, rose and cream, $27.50; mill run, $16. Demand quiet.

Metallic Compounds

ANTIMONY OXIDE—White, Chinese, 99 per cent Sb_2O_3, 10½@11c. per lb. Nominal.

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions. Fair demand and price is steady. London, per long ton, £16 for Cornish white.

CALCIUM MOLYBDATE OR MOLYTE — Per lb. of contained Mo, 95c.

COPPER SULPHATE (Blue Vitriol)—Per lb. in car lots, 5½@6c. for either large or small crystals.

SODIUM NITRATE—Per 100 lb.; crude natural, in bags ex vessel, Atlantic ports, $2.12 for December deliveries.

SODIUM SULPHATE (Salt Cake)—Per ton, bags, f.o.b. works, $21@$22; in barrels, $25@$27.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6⅝c.; French red seal, in bags, 9½c.

[1]Price furnished by Foote Mineral Company, Philadelphia.

Alloys

[1]FERROCERIUM—Per lb., $6 in 100-lb. lots.

FERROCHROME—Per lb. of contained chromium, 4 to 6 per cent carbon, 11c. on requirement contracts; spot shipments 11½c. Maximum 2 per cent carbon, 19c., contracts. Freight allowed on carload lots east of Mississippi River and north of Baltimore.

FERROMANGANESE — Per gross ton furnace: Domestic and foreign, 78@82 per cent, $105. Spiegeleisen, 19@21 per cent, $34 on carload business, f.o.b. furnace.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.20.

FERROPHOSPHORUS—Per ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50; f.o.b. *Alabama* and *Tennessee*.

FERROSILICON—Per gross ton, f.o.b. works, freight allowed on carload lots east of Mississippi River and north of Baltimore: 50 per cent, $83.50; 75 per cent, $130; 15@17 per cent, $45, f.o.b. Suspension Bridge, N. Y. Quotations for spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton: $160, f.o.b. producer's plant.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.45 f.o.b. works.

FERROVANADIUM—Per lb. of V contained, f.o.b. works, freight allowed east of Mississippi, $3.15@$3.50, depending on grade and quantity.

NICKEL SILVER—Per lb. for 18 per cent nickel Grade A sheets, 34½c.

YELLOW (MUNTZ) METAL—Dimension sheets, per lb., 25c.; rods per lb., 22½c.

Rolled Metals

COPPER—Sheets, hot-rolled, per lb., 27½c.; wire, per lb., f.o.b. mill, 19⅞c.

LEAD SHEETS—Full rolled, 10½c. per lb.; clipped, 10½c.

MONEL METAL—Per lb., sheets, full finished, 42c.; rods, hot-rolled, 35c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

ZINC SHEETS—Per lb., 10½c., f.o.b. works.

Refractories

CHROME BRICK—Per net ton, f.o.b. shipping point, $45.

FIRECLAY BRICK — Per M.: First quality, $43@$46, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35 @$38.

MAGNESITE—Brick, per net ton, f.o.b. works: 9-in. straights, $65, f.o.b. plant. Cement, $40, seaboard.

SILICA BRICK—Per M., *Pennsylvania* and *Ohio*, $43; *Alabama*, $51; *Illinois*, $52.

ZIRKITE—Per lb.; Powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Mining Stocks—Week Ended November 30, 1929

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda Copper	New York	81	75	77⅜	Oc. 11 No. 18 Q	1.75
Andes Copper	New York	36½	32½	34	Oc. 11 No. 11 Q	0.75
Arizona Com	Boston	1½	1½	1½	Jl. 16 Jl. 31 SA	0.25
Calumet & Aris	New York	92½	84½	89½	De. 6 De. 23 Q	2.50
Calumet & Hecla	New York	36½	32½	32½	No.30 De. 31 Q	1.50
Cerro de Pasco	New York	67½	60½	64	Oc. 10 No. 1 Q	1.50
Con. Coppermines	N. Y. Curb	6½	5½	6		
Copper Range	Boston	17⅝	16¼	16½	De. 14, Ja. 15 Q	0.50
East Butte	Boston	2	1⅝	1⅝	No.20, De.21	0.25
Granby Con	New York	58½	50½	53½	Oc. 18 No. 1 Q	2.00
Greene Cananea	New York	116½	115	115	De. 12 Ja. 6 Q	2.00
Howe Sound	New York	39½	34½	37½	Se. 30 Oc. 15 Q	1.00
Hudson Bay	N. Y. Curb	11½	10½	10⅝		
Inspiration	New York	31	27½	28⅝	De. 19 Ja.6 Q	1.00
Isle Royale	Boston	17	15½	15½	No.30, De.31 Q	0.50
Kennecott	New York	62½	55½	57½	No. 29, Ja. 2 Q	1.25
Magma Copper	New York	50½	45½	47½	Se. 30, Oc. 15 Q	1.25
Mason Valley	N. Y. Curb	2	2	2		
Miami Copper	New York	30½	26	27½	No. 1, No. 15 Q	1.00
Mohawk	Boston	46	44	44	Oc. 3, De. 2	3.00
Mother Lode	New York	2	1½	2	De. 9, De. 31	0.20
Nevada Con	New York	31⅛	27½	30	Se. 18, Se. 30 Q	0.75
Noranda	N. Y. Curb	36	33½	34½	De.10, Ja.2 Q	0.75
Ohio Copper	N. Y. Curb	1⅛	1	1⅛	Sept., 1926	0.03
New Dominion	Boston	7	6½	6½	Dec., 1918	1.00
Phelps Dodge	New York	43½	38⅛	39	De. 6, Ja. 2 Q	0.75
Quincy	Boston	21	18	18	March, 1920	1.00
Roan Antelope	N. Y. Curb	30	26⅛	26⅛		
St. Mary's M. L.	Boston	27½	25½	25½	No. 29, De. 10	1.00
Seneca Copper	New York	3	2½	2½		
Shattuck Denn	N. Y. Curb	9⅛	8½	8½		
Sheritt-Gordon	Toronto	3.98	3.50	3.60		
Tenn. C. & C.	New York	12½	11½	12	No. 30, De. 16 Q	0.25
United Verde Ex	N. Y. Curb	13½	12½	12½	Oc. 2, No. 1 Q	1.00
Utah Copper	New York	224½	224½	224½	Se. 18, Se. 30 Q	4.00
Waite-Ack.-Mont	Toronto	3.80	3.50	3.50		
Walker Mining	Salt Lake	4.00	3.90	3.90		
Wenden Copper	N. Y. Curb	*87½	*62½	*87½		
LEAD, ZINC, SILVER						
Ahumada Lead	New York	1.00	*75	*87½		
Amer. Z. L. & S.	New York	11½	9½	10	May, 1917	1.00
A. Z. L. & S., pfd.	New York	61½	57½	57½	De. 12, Ja. 1 Q	1.50
Bunker Hill & S.	N. Y. Curb	104½	104½	104½	Oc. 24, No. 5 X	0.75
Butte Cop. & Zn.	New York	5	4	4	De.10, De.25	0.50
Butte Cop. Con	Boston Curb	....	....	*31½		
Butte & Sup	New York	6	5½	6	Je. 14, Je. 29 Q	0.50
Callahan Zn-Ld	New York	1⅛	1⅛	1⅛	Dec., 1920	0.50
Chief Consol	Salt Lake	2.15	2.00	2.02½	Fe. 1, 1918 K	0.10
Consol. Ld. & Zn. "A"	St. Louis	8	7½	7½	Se. 20, Oc. 1 Q	0.25
Constitution	Spokane	*39½	*35	*38½		
Dayrock	Spokane	2.00	1.82	1.98	Je. 20, Je. 30	0.03
Dickens Consol	Spokane	*4¼	*4¼	*4¼		
Eagle-Picher	Cincinnati	13½	13	13	Se. 30, Oc. 15 Q	0.20
Eagle-Pich., pfd.	Cincinnati	....	....	101	Se. 30, Oc. 15 Q	1.50
Erupcion	Boston Curb	....	....	*12	Jan. 1, 1928	0.07½
Eureka Bullion	Salt Lake	*57½	*49	*49½		
Evans-Wallower	N. Y. Curb	5½	5	5½		
Evans-Wal., pfd.	N. Y. Curb	....	....	10½	Je. 20, Jl. 1 Q	1.75
Federal M. & S.	New York	190	190	190	June, 1927	10.00
Fed. M. & S., pfd.	New York	....	....	98½	No. 25, De.16 Q	1.75
Gladstone	Spokane	*2	*1½	*1½		
Golconda	Spokane	*80	*76½	*76½	Je. 15, Jl. 1	0.02
Grandview	Spokane	*23½	*22½	*23		
Hecla Mining	N. Y. Curb	14	14	14	No. 15, De. 15 Q	0.25
Highland-Surprise	Spokane	*8	*6	*8		
Jack Waite	Spokane	*11	*8½	*8½		
Kootenay Florence	Spokane	*9	*8½	*8½		
Lucky Jim	Spokane	*6	*6	*6		
Lucky Tiger-C	Kansas City	....	†2.25	....	No. 9, No. 20 M	0.02½
Mexican Premier	Spokane	1.89	1.87	1.87		
National Lead	New York	146½	140	140	De. 13, De. 31 Q	1.25
Natl. Lead, pfd. A	New York	139½	138	138	Nv.29, De.14 Q	1.75
Natl. Lead, pfd. B	New York	116	116	116	Je. 17, Fe. 1 Q	1.50
N. J. Zinc, new	N. Y. Curb	70	69½	69½	No.20, De. 10 X	0.50
New Quincy	Salt Lake	1.15	*99	1.70	Se. 20, Se. 30 Q	0.10
Noble Five	Spokane	*40	*38	*40		
North Lily	Salt Lake	4.25	3.90	3.90	Oc. 16, Oc. 23	0.25
Park Bingham	Salt Lake	....	....	*7½		
Park City Con	Salt Lake	1.00	1.00	1.00		
Park Utah	New York	4	3½	3½	Dividends suspended	
Pend Oreille	Spokane	3.00	2.80	3.00		
Rico Argentine	Salt Lake	....	....	*19	No. 30, De. 15 Q	0.03
Ruth-Hope	Spokane	*20	*18	*20		
St. Joseph Lead	New York	50½	47	47½	Se. 10, Se. 20 QX	0.75
Sherman Lead	Spokane	*48½	*38	*38		
Silver King Coa	Salt Lake	10.00	10.00	10.00	Se. 20, Oc. 1 Q	0.25
Silversmith	Spokane	*6½	*6½	*6½	Oct., 1926	0.02
Sunshine Mining	Spokane	5.40	5.00	5.00	Se. 10, Se. 20 Q	0.05
Tamarack-Custer	Spokane	*44	*40	*43	Sept., 1924	0.25
Tintic Standard	Salt Lake	10.62½	10.50	10.62½	Se. 17, Se. 20 X	0.30
Tonopah Belmont	N. Y. Curb	....	....	*37½	Oct., 1925	0.05
Treadwell-Yukon	Toronto	....	....	7.50		
United Zinc Smg, New	N. Y. Curb	....	....	7		
Utah Apex	Boston	3½	3	3	Oc. 15, No. 1	0.25
Utah Met. & Tun	Boston	*85	*70	*70	Dec., 1927	0.30
Whitewater	Spokane	*23	*20	*20		
Yellow Pine	Los Angeles	....	....	*8	Dec., 1925	0.04
GOLD						
Alaska Juneau	New York	6½	5½	6		
Barry-Hollinger	Toronto	*20	*17	*18		
Central Manitoba	Toronto	*27	*23	*23		
Creason Consol	N. Y. Curb	*43½	*37½	*37½	Se. 30, Oc. 10 Q	0.02
Dome Mines	New York	7½	6½	7	De. 31, Ja. 20 Q	0.25
Golden Cycle	Col. Springs	†15.25	†14.25	....	Au. 31, Se. 10 Q	0.04
Hollinger	Toronto	5.30	5.00	5.10	No.15, De.2 FW	0.05
Homestake	New York	80	80	80	No.20, No.25 M	0.50
Kirkland Lake	Toronto	*60	*54	*54		
Lake Shore	Toronto	20.00	19.25	19.25	De.2, De.16 Q	0.30
McIntyre Porcupine	New York	....	....	14	Nv. 1, De. 2 Q	0.25
Portland	Col. Springs	†*8	†*6	....	April, 1927	0.01
Rand Mines	New York	....	....	25	Au.21, 29 A.s.	1.50
Siscoe	Toronto	*60	*50	*50		
Sylvanite	Toronto	*50	*49	*50		
Teck-Hughes	Toronto	5.25	5.00	5.10	Oc. 18, No. 1	0.15
Tom Reed	Los Angeles	*54	*50	*50	Dec., 1926	0.02
Unity Gold	N. Y. Curb	*50	*50	*50		
Vipond Consol	Toronto	*65	*61	*61	April, 1927	0.03
Wright-Hargreaves	Toronto	1.37½	1.25	1.26	Oc. 16, No. 1	0.02½
Yukon-Alaska	N. Y. Curb	....	....	35½		
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	8¼	8⅛	8¼		
Castle-Trethewey	Toronto	*29	*28½	*28½		
Consol. Cortez	N. Y. Curb			*6½		
Dolores Esperanza	N. Y. Curb	*18½	*18½	*18½	July, 1923	0.05
Keeley	Toronto	*35	*35	*35	Mr. 15, 1928	0.04
Mining Corp	Toronto	3.35	3.16	3.25	De. 4, De. 19	0.12½
Montana-Mines Corp.	Spokane	*39½	*36½	*36½		
N. Y. & Hond. Ros	N. Y. Curb	14½	14½	14½	Oc.16, Oc.26 QX	0.50
Nipissing	N. Y. Curb	1⅞	1⅞	1⅞	De. 31, Ja. 20 Q	0.07½
Premier Gold	N. Y. Curb	....	....	1⅝	Se. 12, Oc. 3 Q	0.06
Tonopah Exten	N. Y. Curb	....	....	*10	April, 1925	0.05
Tonopah Mining	N. Y. Curb	2½	2½	2½	Se. 30, Oc. 21	0.07½
United Eastern	N. Y. Curb	....	....	*18½		
Yukon Gold	N. Y. Curb	....	....	*56½	June, 1918	0.02
IRON AND STEEL						
Bethlehem Steel	New York	91½	88	89½	Jan. 18, Fe. 15 Q	1.50
Beth. Steel, pfd. 7%....	New York	122½	122½	122½	De. 7, Ja. 2 Q	1.75
Cleveland-Cliffs	Cleveland	95	94	94	Se. 5, Se. 15 Q	1.00
Colo. Fuel & Iron	New York	35½	31½	32		
Colo. F. & I., 1st pfd.	New York	134	132	134	No. 10, No. 1 Q	2.00
Great Northern Iron	New York	24½	23½	23½	Dec. 15 K	2.00
Inland Steel	New York	75	74½	74½	No. 15, De. 1 Q	0.87½
Republic I. & S.	New York	75	70½	70½	No. 12, De. 2 Q	1.00
Republic I. & S. pfd.	New York	105	104	104	De. 12, Ja. 2 Q	1.75
Sloss-Sheffield S. & I.	New York	32	32	32	Mr. 11, Mr. 20Q	1.50
Sloss-Sheff. S.&I., pfd.	New York	66½	66½	66½	Se. 20, Oc. 1 Q	1.50
U. S. Steel	New York	38½	35½	36½	No.30, De.30 QX	2.75
U. S. Steel, pfd.	New York	51½	50½	51	No. 2, No. 29 Q	1.75
Virginia I. C. & C.	New York	....	....	15½	Jan., 1924	1.50
Virginia I.C.&C., pfd.	New York	40	40	40	Jl. 16, 1928 SA	2.50
MISCELLANEOUS						
Aluminum Co. of Am.	N. Y. Curb	259½	235½	236		
Alum. Co. of Amer., pf.	N. Y. Curb	107½	107	107	Mr. 15, Ap. 1 Q	1.50
American Metal	New York	44½	40½	42½	No. 20, De.2 Q	0.75
Amer. Metal, pfd., 6%	New York	....	....	111½	No. 20, De.2 Q	1.50
Amer. Sm. & Ref.	New York	76	70	70	Oc. 11, No. 1 Q	1.00
Amer. Sm. & Ref., pfd.	New York	135	134½	135	No. 1, De. 2 Q	1.75
Ang. Ch. Nitrate	N. Y. Curb	23	21½	21½		
Asbestos Corp	Montreal	3	2½	3	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal	12	10	10	De. 31, Ja. 15 Q	1.75
Consol. M. & S.	Montreal	270	261	268	Je. 29, Jl. 15 SA	6.25
De Beers Consol	New York	....	....	21	Jl. 23, Jl. 26 Q	0.96
Federated Metals	N. Y. Curb	25	24½	25	Oc. 3, Oc. 11 Q	0.25
Freeport Texas	New York	36⅞	34	35½	Oc. 15, No. 1 Q	1.00
Int. Nickel Can.	New York	31½	28½	30½	No. 30, De. 31 Q	0.25
Int. Nickel, pfd.	New York	113	112	113	Se. 28, No. 1 Q	1.75
Mayflower Assoc	N. Y. Curb	52	47½	52		
Metal & Mining	N. Y. Curb	10⅛	8½	10⅛	Se. 21, Oc. 1	0.30
Newmont	N. Y. Curb	131	118	125	Se. 30, Oc. 15 Q	1.00
Patino M. & E.	New York	32½	31	31½	De. 7, De. 24	4s.
So. America G. & P.	N. Y. Curb	1½	1½	1½		
Texas Gulf Sulphur	New York	57½	55½	56½	De. 2, De. 16 Q	1.00
U. S. Sm. R. & M.	New York	38⅜	35⅜	36½	Oc. 7, Oc. 15 Q	0.87½
U. S. Sm. R. & M., pfd	New York	51½	50½	51	Oc. 7, Oc. 15 Q	0.87½
Vanadium Corp	New York	53¾	50½	52	Nv.1, De.16 QX	1.75

Toronto Standard Stock Exchange, Toronto, courtesy the Arthur E. Moysey Co.; Salt Lake Stock Exchange, courtesy J. A. Hogle & Co. and Logan & Bryan, New York; Standard Stock Exchange, Spokane, courtesy Pohlman Investment Company

*Cents per share. †Bid or asked. Q, Quarterly. A. Annually. SA, Semi-annually. M, Monthly. BM, Bimonthly. FW, Four weeks. K, Irregular. I Initial. R, Respumption. X, Extra. The first date given is that of the closing of the books; the second that of the payment of the dividend. A.s., American shares.

LONDON QUOTATIONS—WEEK ENDED November 19, 1929

	High	Low	Last	Date	Amount
Alaska Mexican ($5)	12/6	12/6	12/6		
Alaska Treadwell ($25)	60/—	60/—	66/—	Nov., 1926	4 p.c.
Aramayo Mines (25 frs.)	42/6	40/—	40/—	Nov., 1929	5 p.c.
Burma Corpn. (10 rupees)	17/1½	16/1½	16/10½	July, 1929	9 annas*
Bwana M'Kubwa (5s)	22/4½	15/9	20/6		
Camp Bird (2s)	1/7½	1/3	1/6	April, 1928	16⅔ p.c.
El Oro (5s)	3/7½	3/1½	3/3	Nov., 1929	20⅝ p.c.*
Frontino & Bolivia (£1)	8/—	8/—	8/—	Jan., 1929	3½ p.c.
Mexican Corpn. (£1)	12/10½	12/1½	12/3	Oct., 1929	10 p.c.
Mexico Mines of El Oro (£1)	3/1½	3/1½	1/9	Dec., 1926	3½ p.c.*
Mount Isa (£1)	30/7½	25/1½	27/6		
N'Changa Copper Mining (£1)	35/7½	20/—	30/—		
Oroville Dredging (4s)	1/8½	1/4½	1/6	Nov., 1928	31½ p.c.
Rhodesian Congo Border (£1)	148/9	115/—	120/—		
St. John del Rey (£1)	16/10½	16/—	16/6	Dec., 1929	2½ p.c.
San Francisco Mines (10s)	30/—	27/3	29/4½	June, 1929	15 p.c.
Santa Gertrudis (£1)	11/3	10/6	11/3	July, 1929	7½ p.c.
Selukwe (2s. 6d.)	4/9	3/9	4/6	April, 1917	6⅔ p.c.
S. Amer. Copper (2s)	1/10½	1/6	1/9	Nov., 1917	75 p.c.
Tanganyika (£1)	46/3	38/6	42/6	July, 1929	7½ p.c.
Union Miniere du Haut-Katanga (Brussels)	9,775	9,300	9,775	April, 1929	300 fr. (‡)

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian francs and free of taxation.